

SECTION-3

3.01 - 3.99

DIRECTION FINDING

LOCATION OF JAPANESE DIRECTION FINDER STATIONS

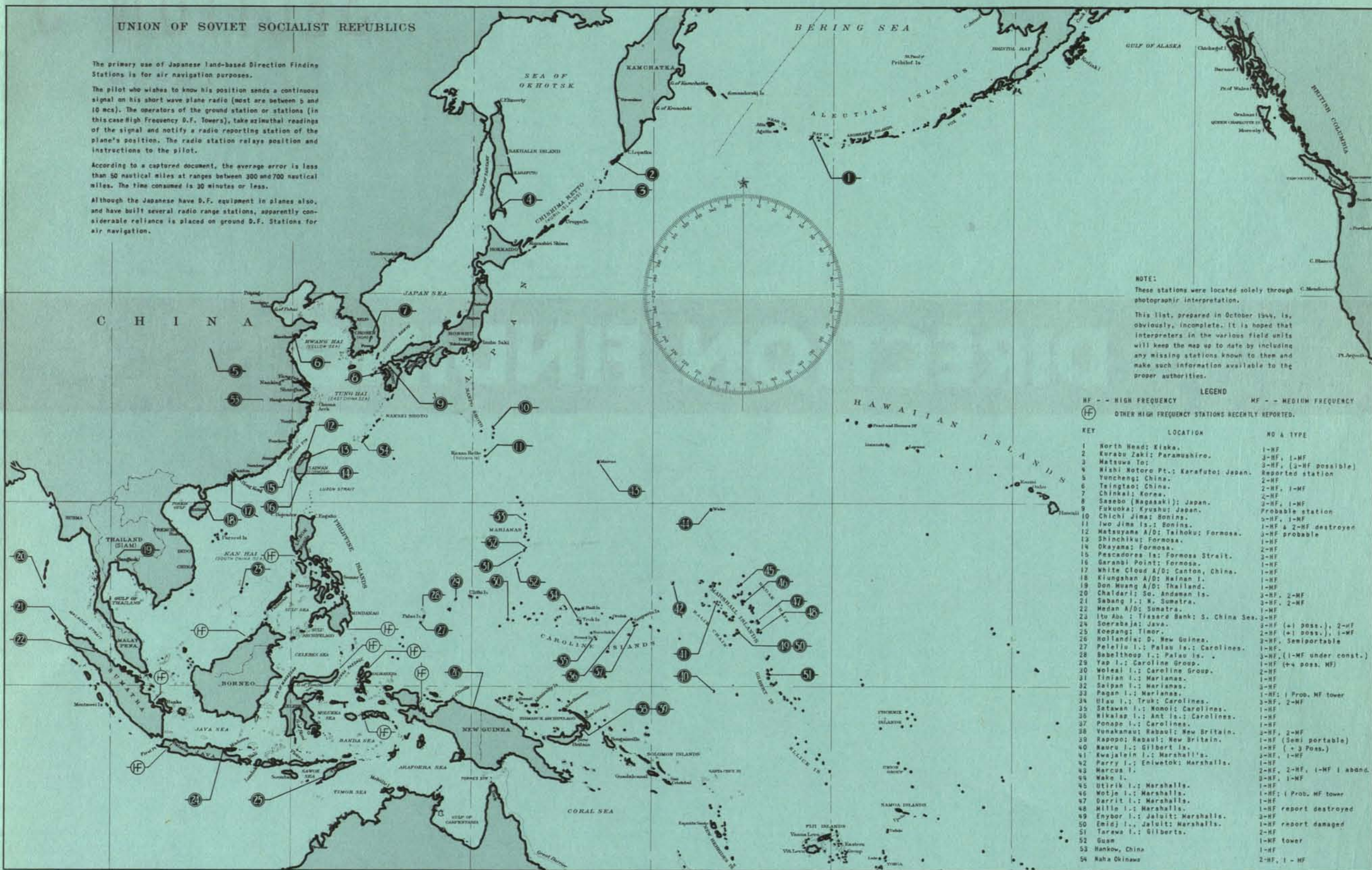
UNION OF SOVIET SOCIALIST REPUBLICS

The primary use of Japanese land-based Direction Finding Stations is for air navigation purposes.

The pilot who wishes to know his position sends a continuous signal on his short wave plane radio (most are between 5 and 10 mcs). The operators of the ground station or stations (in this case High Frequency D.F. Towers), take azimuthal readings of the signal and notify a radio reporting station of the plane's position. The radio station relays position and instructions to the pilot.

According to a captured document, the average error is less than 50 nautical miles at ranges between 300 and 700 nautical miles. The time consumed is 30 minutes or less.

Although the Japanese have D.F. equipment in planes also, and have built several radio range stations, apparently considerable reliance is placed on ground D.F. Stations for air navigation.



NOTE:

These stations were located solely through photographic interpretation.

This list, prepared in October 1944, is, obviously, incomplete. It is hoped that interpreters in the various field units will keep the map up to date by including any missing stations known to them and make such information available to the proper authorities.

HF -- HIGH FREQUENCY
MF -- MEDIUM FREQUENCY
OTHER HIGH FREQUENCY STATIONS RECENTLY REPORTED.

KEY	LOCATION	NO & TYPE
1	North Head; Kiska.	1-HF
2	Kurabu Zaki; Paramushiro.	3-HF, 1-MF
3	Matsuwa To.	3-HF, (3-MF possible)
4	Nishi Motono Pt.; Karafuto; Japan.	Reported station
5	Yuncheng; China.	2-HF
6	Teingtao; China.	2-HF, 1-MF
7	Chinkai; Korea.	2-HF
8	Sasebo (Nagasaki); Japan.	3-HF, 1-MF
9	Fukuoka; Kyushu; Japan.	Probable station
10	Chichi Jima; Bonins.	5-HF, 1-MF
11	Iwo Jima Is.; Bonins.	1-HF & 2-HF destroyed
12	Matsuyama A/D; Taihoku; Formosa.	3-HF probable
13	Shinchiku; Formosa.	1-HF
14	Okayama; Formosa.	2-HF
15	Pescadore Is; Formosa Strait.	3-HF
16	Sarangi Point; Formosa.	1-HF
17	White Cloud A/D; Canton, China.	1-HF
18	Kiungshan A/D; Hainan I.	1-HF
19	Don Huang A/D; Thailand.	1-HF
20	Chaidari; So. Andaman Is.	3-HF, 2-MF
21	Sabang I.; S. Sumatra.	3-HF, 2-MF
22	Medan A/D; Sumatra.	1-HF
23	Itu Aba; Tisserand Bank; S. China Sea.	3-HF
24	Soerabaja; Java.	3-HF (+1 poss.), 2-MF
25	Koepang; Timor.	2-HF (+1 poss.), 1-MF
26	Hollandia; D. New Guinea.	2-HF, Semiportable
27	Peleliu I.; Palau Is.; Carolines.	1-HF
28	Babelthou I.; Palau Is.	3-HF, (1-MF under const.)
29	Yap I.; Caroline Group.	1-HF (+4 poss. MF)
30	Woleai I.; Caroline Group.	2-HF
31	Tinian I.; Marianas.	1-HF
32	Saipan I.; Marianas.	3-HF
33	Pagan I.; Marianas.	1-HF; 1 Prob. MF tower
34	Hlau I.; Truk; Carolines.	3-HF, 2-MF
35	Satawan I.; Monol; Carolines.	1-HF
36	Nikalap I.; Ant. Is.; Carolines.	1-HF
37	Ponape I.; Carolines.	1-HF
38	Yunakama; Rabaul; New Britain.	3-HF, 2-MF
39	Rapopo; Rabaul; New Britain.	1-HF (Semi portable)
40	Kauru I.; Gilbert Is.	1-HF (+3 Poss.)
41	Kwajalein I.; Marshalls.	3-HF, 1-MF
42	Parry I.; Eniwetok; Marshalls.	1-HF
43	Marcus I.	2-HF, 2-MF, 1-MF 1 abnd.
44	Wake I.	3-HF, 1-MF
45	Utrik I.; Marshalls.	1-HF
46	Wotje I.; Marshalls.	1-HF; 1 Prob. MF tower
47	Darrit I.; Marshalls.	1-HF
48	Mille I.; Marshalls.	1-HF report destroyed
49	Enybor I.; Jaluit; Marshalls.	2-HF
50	Emidj I.; Jaluit; Marshalls.	1-HF report damaged
51	Tarawa I.; Gilberts.	2-HF
52	Guam	1-HF tower
53	Hankow, China	1-HF
54	Naha Okinawa	2-HF, 1-MF

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DIRECTION FINDING SUMMARY

Direction finders are RECEIVERS of radio signals. They are equipped to determine the direction from which such radio signals are being sent. D.F.ing is possible on any transmitting equipment operating in the same frequency band as the D.F. receiver.



D.F. STATION AT TRUK

D.F. installations are used on aircraft and on naval vessels as well as on land. This section, however, deals primarily with fixed land installations. D.F. is often used by the Japanese as an aid to aerial navigation in addition to its use for intelligence purposes. In such cases the customary procedure is as follows:

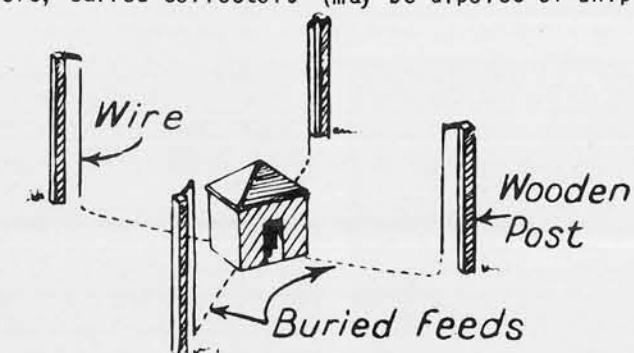
When Japanese pilots desire bearings from these stations, they hold down on the key sending a continuous signal on which an azimuth reading is taken by the D.F. operator. The bearing is then transmitted to the pilot via a radio communications station which is usually found near a D.F. installation.

TYPES OF D.F.

There are two basic types of direction finders - the loop and the Adcock. Although the loop method is used on aircraft and ships, the majority of Japanese land based D.F. stations photographed to date operate on the Adcock system.

ADCOCK

The Japanese style Adcock, in simplest form, may be described in this manner: Four vertical members arranged in a square, with the receiver in the center, and with diagonal electrical connections between the center and all four vertical members, called collectors (may be dipoles or unipoles).



This arrangement is augmented by a central sensing antennae (frequently not visible but which determines the direction of the signal after the line of bearing has been established.)

Example: When the unipoles determine the signal to be on 10° - 190° line the central sensing antennae indicates whether the signal is coming from 10° or from 190° .

This type may also be referred to as "fixed Adcock" in that the unipoles or dipoles do not rotate. It may be either completely housed or the collectors may be exposed.

As in Radio Communications, D.F. is catalogued by frequency. The common types are in the High and Medium frequency ranges.

TABLE OF FREQUENCIES

FREQUENCY	UNIPOLE OR (DIPOLE) DIAGONAL SPACING	UNIPOLE (OR DIPOLE) HEIGHT	WAVE LENGTH IN METERS	FREQUENCY IN MEGACYCLES PER SEC.
HIGH ("HOUSED ADCOCK")	20' TO 30' (MOST ARE 25')	15' TO 25'	100 TO 10 M	3 TO 30 MCS.
MEDIUM ("OPEN ADCOCK")	90' TO 150' (MOST ARE 100')	50' TO 75'	1000 TO 100 M	0.1 TO 3 MCS.

DIRECTION FINDING

SUMMARY (CONT.)

SPACING AND HEIGHT OF UNIPOLES

The frequency of Adcock type D. F. is determined by the photographic Interpreter from the spacing and height of the collectors (unipoles or dipoles).

Rule of thumb method for determining wave length:

Minimum wave length in meters = $\frac{\text{diagonal distance between collectors}}{0.2}$

Translation to frequency:

Frequency in Kilocycles = $\frac{300000}{\text{Wave length in meters}}$



PONAPE, CAROLINES

Example of High Frequency D.F. with Radio Reporting Station nearby.

D. F. CENTERS

Many D.F. centers have easily recognizable "T", "H", or "L" shaped buildings which contain offices, communications, barracks, baths, messing facilities, power plant, storage etc.

The various elements are one story in height and are connected by narrow covered passageways.



DARRITT, MAJURO, MARSHALLS

General Notes on Japanese D. F.

1. Located near airfields (and other locations).
2. Site is well cleared, fairly level and high.
3. Pattern of roads and paths connecting installations, usually visible.
4. Radio communications station (reporting station) is always present or near at hand.
5. High and Medium frequency set-ups are usually present in combination at important D. F. centers.
6. A Japanese D. F. center usually consists of:
 - (a) high frequency installation, or
 - (b) two high frequency installations, or
 - * (c) three high frequency installations, or
 - (d) one medium frequency installation, or
 - * (e) two medium frequency installations, or
 - (f) combinations of high and medium frequency up to a usual maximum of three high and two medium.

* = most often found

NOTE: D. F. stations at Chichi Jima and at Matsuwa have 6 H. F. Towers. These cases, however, are exceptional and were the result of additions to the original stations.

DUPLICATION OF INSTALLATIONS

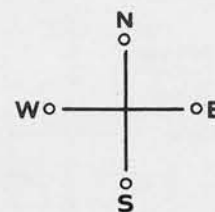
The Japanese frequently build duplicate installations of the same frequency on the same site. The building arrangement is considered as having no particular electrical significance.

Probable reasons:

1. To operate at slightly different frequencies at the same time within a given frequency range.
2. For security reasons - in the event of damage or breakdown of equipment.
3. When spread out over long distances they may be used to locate objective by triangulation.

ORIENTATION

The preferred method of orientation is as follows:



Open Adcock



Housed Adcock

Ordinarily, D. F. installations are constructed with a definite relationship to North. The sides of all buildings usually fall in a constant relation to North and therefore, are parallel to each other.

It is an advantage, when constructing D. F. stations, to establish and incorporate the direction of North into the construction of collectors at an early stage. Thus, when the layout is installed, the calibrations for azimuth readings are easily related to a fixed reference line.

DIRECTION FINDING

SUMMARY (CONT.)

HIGH FREQUENCY ADCOCK

The Japanese usually construct the high frequency Adcock in a house which encloses the dipoles within its walls, one set of dipoles being in each corner.

This installation which is called "Housed Adcock" has been standardized to some extent in use throughout the Pacific islands.

PATTERNS

Although found in ones, twos, and threes, most stations have three Housed Adcocks arranged in a triangle or on a straight line. Arrangements vary to such an extent that identification cannot be based on pattern.

The type most often found is identified best by the following key dimensions: Plan view - 23' x 23' (including roof overhang). Interior - 20' x 20'.

Height - 32' (from ground to eave)

Buttresses - 5' spread at base

* (Note: Hereafter, this type of station will be called a "Housed Adcock" or "High Frequency D. F. tower".)

RIGHT: Front view of High Frequency D. F. Receiver. Connections with dipoles are made at the top of instrument which is surmounted by the central sensing antennae. Goniometers are used to determine direction instead of rotating the dipoles which are fixed in the corners of the building.

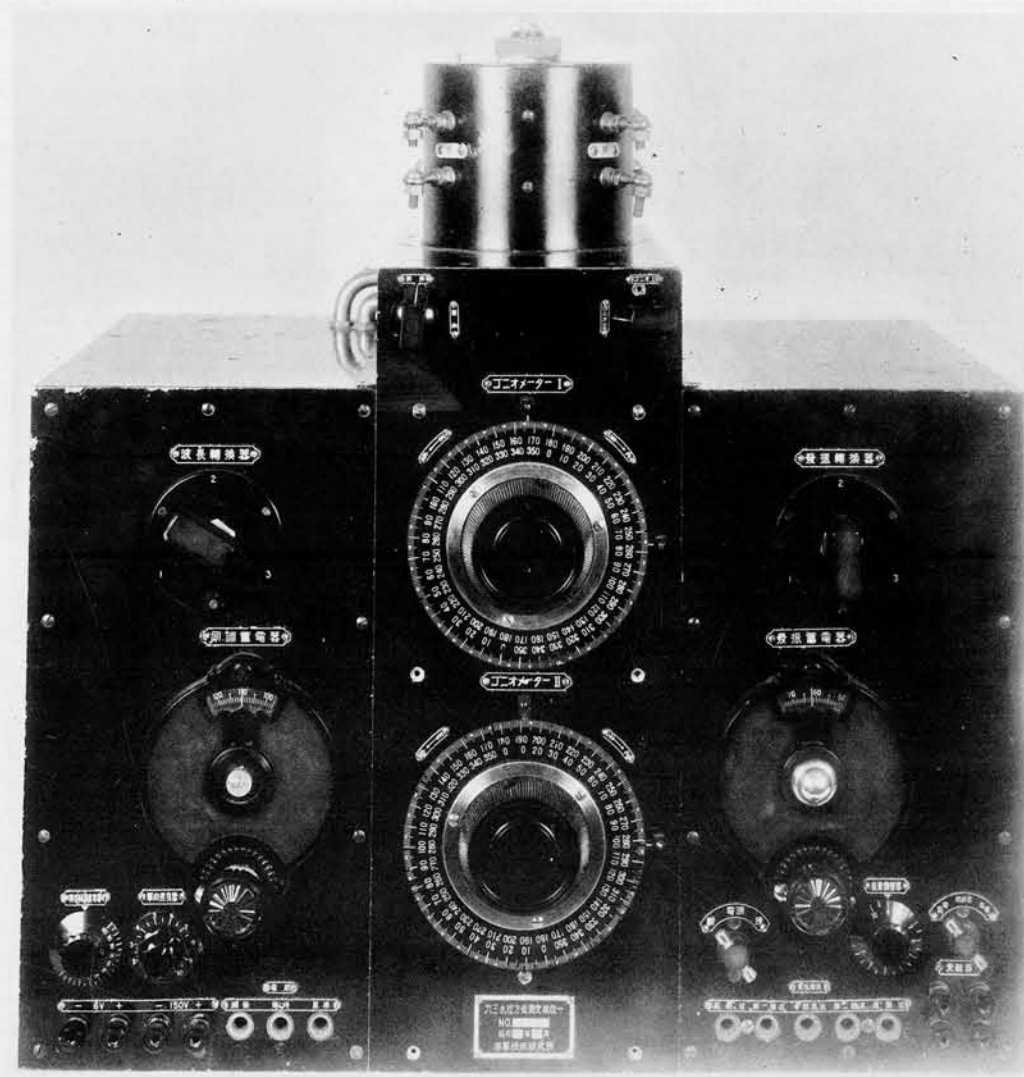
BELOW: High Frequency D. F. tower at Kwajalein. The receiver, dipoles, and operator's table are all enclosed within the walls of this structure. The buttresses, for some unknown reason, are usually present on D. F. towers.



KWAJALEIN



KWAJALEIN



JAPANESE HIGH FREQUENCY D. F. RECEIVER

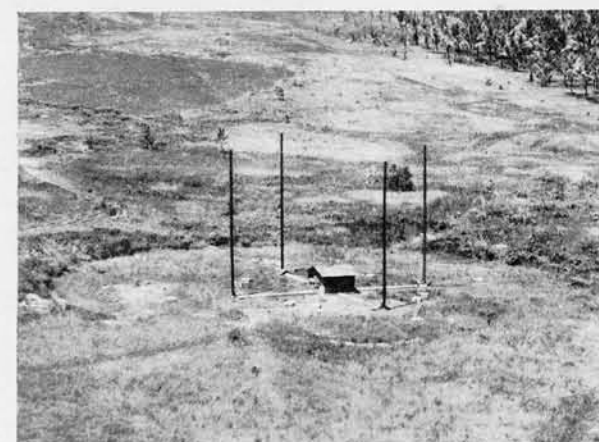
MEDIUM FREQUENCY ADCOCK

Most Japanese Medium Frequency Adcock D. F. stations ("Open Adcock") may be identified by the following keys:

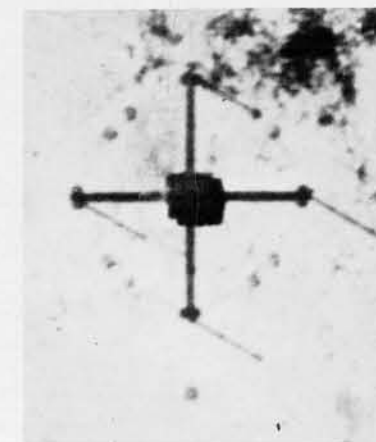
1. Four stick masts (unipoles) arranged in a square pattern.
2. Small hut in center approximately 20 feet square.
3. Strongly visible diagonal lines (cables) connecting unipoles.
4. Diagonal distance between unipoles is approximately 100 feet.
5. 12 Square concrete blocks 3' x 3' anchoring guy wires.

The Medium Frequency Adcock operates in a similar manner to the High Frequency, the main difference being the greater distance between vertical antennae elements which is necessary for efficient medium frequency reception.

The four stick masts found with this installation are called unipoles, electrical connections being made by means of buried feeds leading from each pole to the central hut or shack.



VUNAKANAU, RABAU, NEW BRITAIN



WAKE

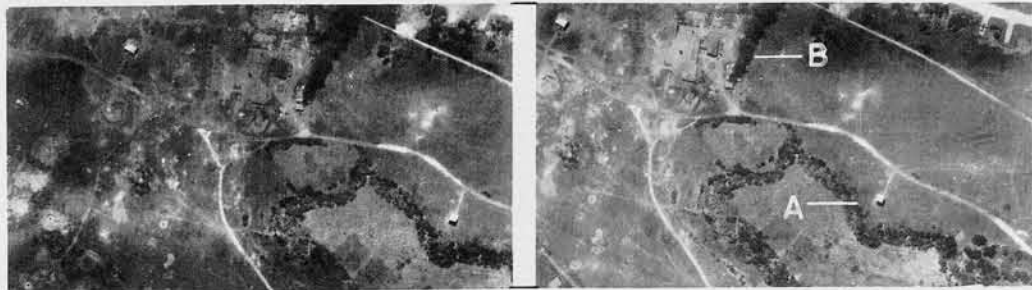
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DIRECTION FINDING

SUMMARY (CONT.)



IWO JIMA



IWO JIMA

(R.F. - 177500)

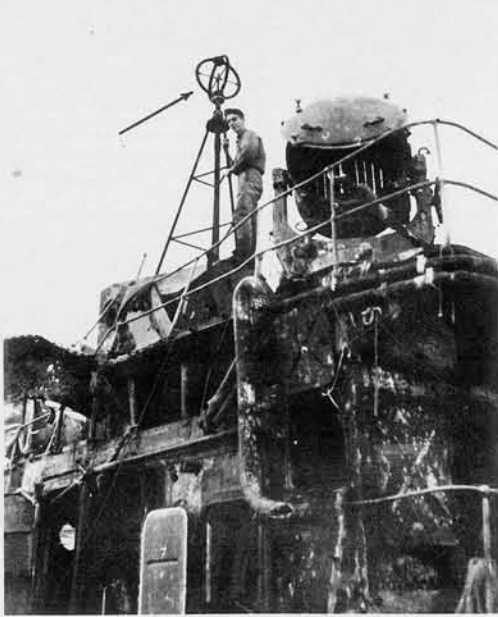
- "A" - TYPE I HIGH FREQUENCY D.F. TOWER
- "B" - D.F. CENTER WITH MEDIUM FREQUENCY RADIO REPORTING STATION

BELOW, LEFT: Two Direction Finding towers at Pagan. The height of the left tower is 32 feet (from ground to eave) while the right tower is about 22 feet high. The short tower design is not used to a great extent, and is thought to house a Naval type Medium Frequency loop D.F. equipment.

BELOW, RIGHT: Medium Frequency loop type D.F. antennae used on Japanese naval vessels.



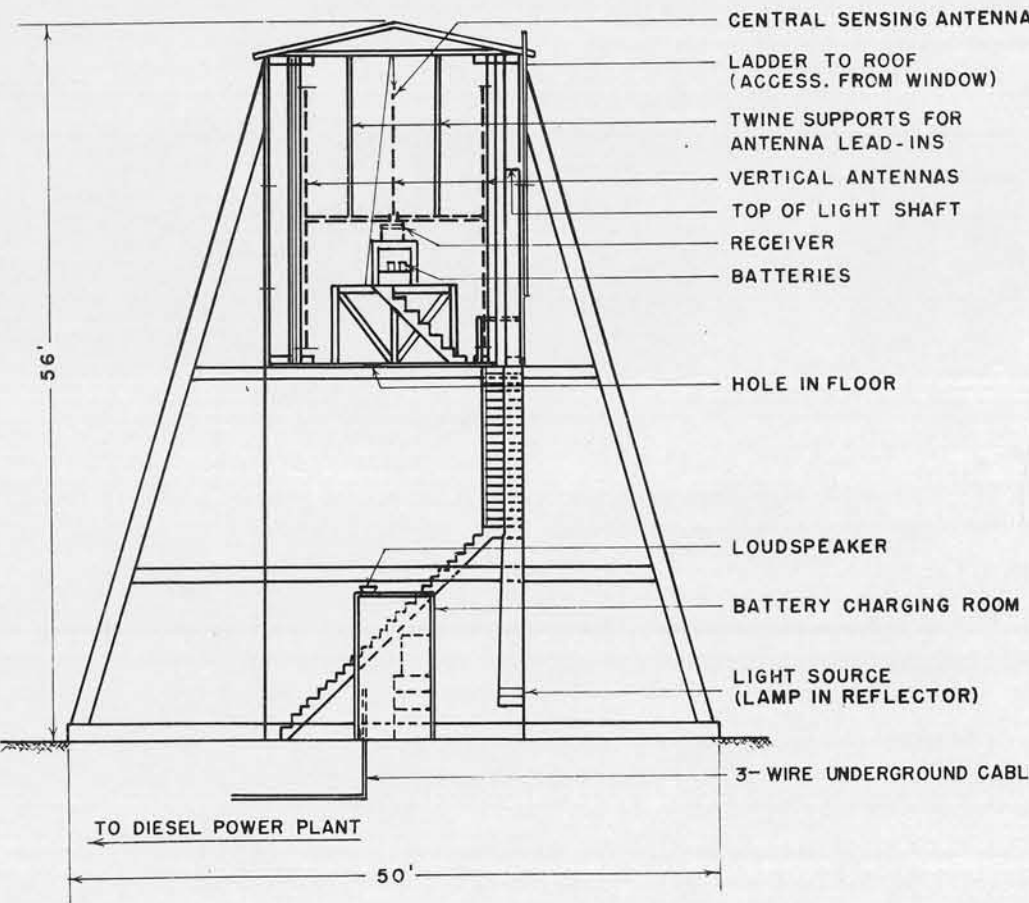
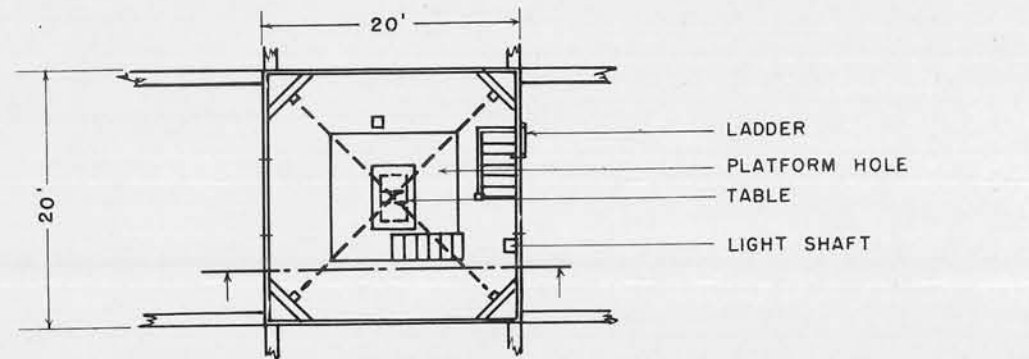
PAGAN, MARIANAS



DIRECTION FINDER ON D. D.

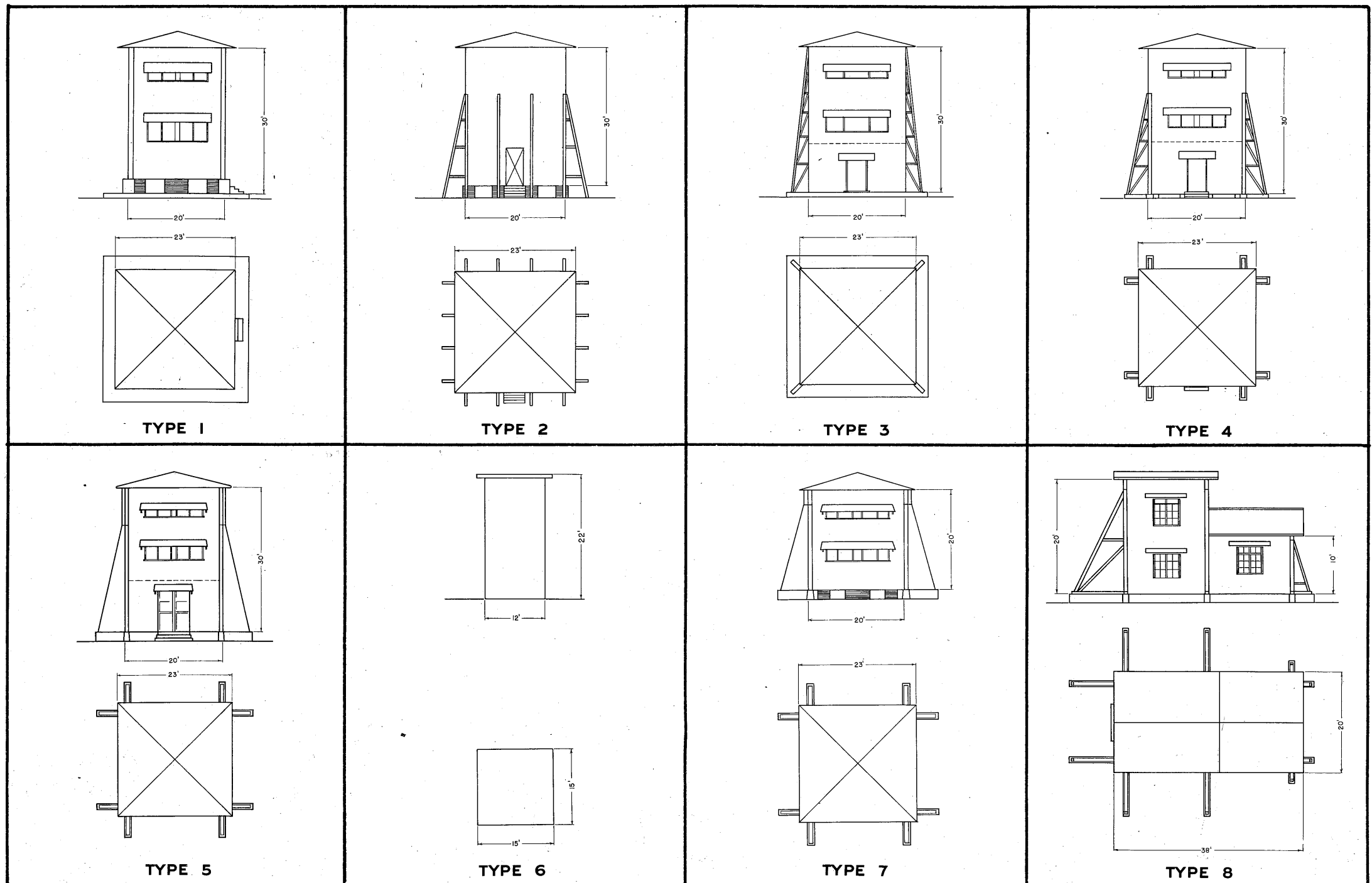
BELOW: The drawing below was made from a High Frequency D.F. tower at Tarawa. It is not a typical design in that it is higher than any others seen to date. However, it is thought that the basic principles of the interior design are characteristic of most Japanese High Frequency D.F. towers.

As can be seen from this diagram, each D.F. tower requires an operator.



DIRECTION FINDING

SUMMARY (CONT.)



On this page are shown eight D.F. tower designs in use by the Japanese. Types "1", "2", "3", "4", and "5" are thought to enclose High Frequency Adcocks. These structures are 20' square by 30'-32' high. Types "6", "7", and "8" are thought to enclose Medium Frequency rotating loop D.F. (similar to naval type). The loop type may be used in a structure with a floor plan of less area than High Frequency fixed Adcock. A 12 foot square plan would allow sufficient space. The best clue, however is in the

height of the structure. 18-20 feet of height is sufficient for a loop type, but is not considered enough for a High Frequency fixed Adcock. Elaborate buttress systems characterize many of these designs. The towers are capable of withstanding abnormally high winds. The towers shown were reconstructed from aerial photographs and not to be regarded as examples of detailed accuracy - but merely key information for identification purposes.

DIRECTION FINDING

HIGH FREQUENCY

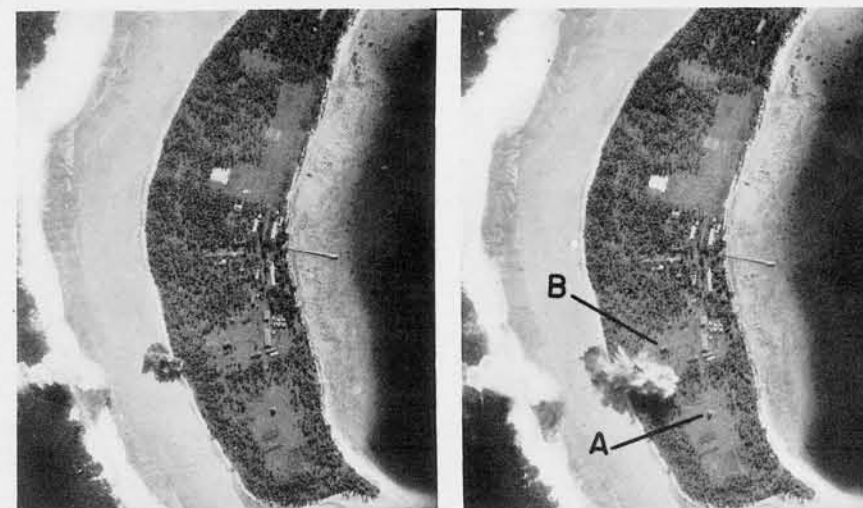


MAJURO

This D.F. setup, when captured on Darritt Island, Majuro, had been abandoned before equipment was installed in the buildings. However, due to the fact that no damage resulted from the occupation, these provide a good opportunity for studying the architectural details of the most recent D.F. building design. Note the finished appearance of the Structures, in which even the buttresses are sheathed with clapboards. This is type "5".



MAJURO

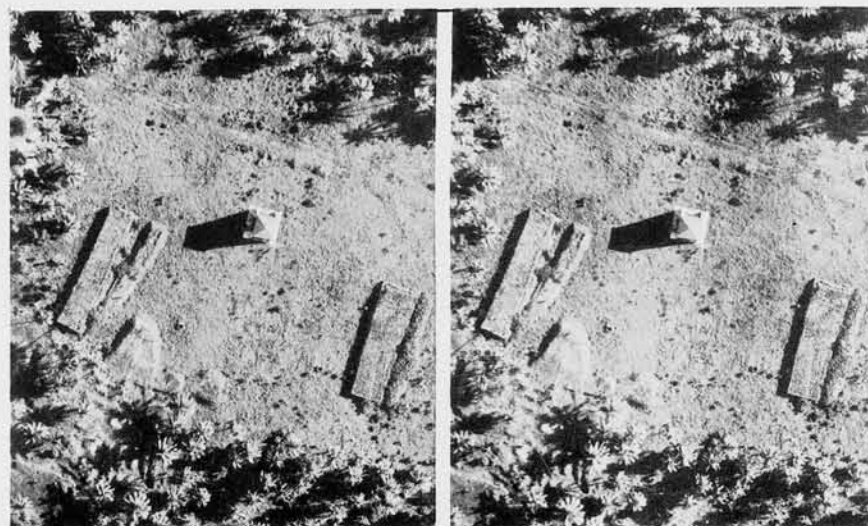


MAJURO

(R.F. - 1/17000)

Above: "A" = High Frequency D.F., "B" = Probable Generator Building

Below are close ups of the two structures erected on Darritt. The one at the left was designed to house the High Frequency D.F. equipment. The building at the right is a standard type, seen usually with large D.F. centers and is thought to be a generator building. However, it may contain a D.F. receiver. This, however, has not been determined from ground information as yet. Approximate dimensions are length -38', width 32', height 22'.



MAJURO

(R.F. - 1/2200)

The above Stereogram shows quite clearly the important identification characteristics of the High Frequency D.F. tower. The hipped roof is 23' to 24' square (including overhang). Height, from ground to eave is 32'. The buttresses, spreading 6' at the base are clearly visible here.



MAJURO

High Frequency D.F. tower

Note that there is but one floor above the ground floor.



MAJURO

Unidentified. Probable Generator Building
This structure was empty when our troops took over Majuro.

DIRECTION FINDING HIGH FREQUENCY (CONT.)



JALUIT, MARSHALLS

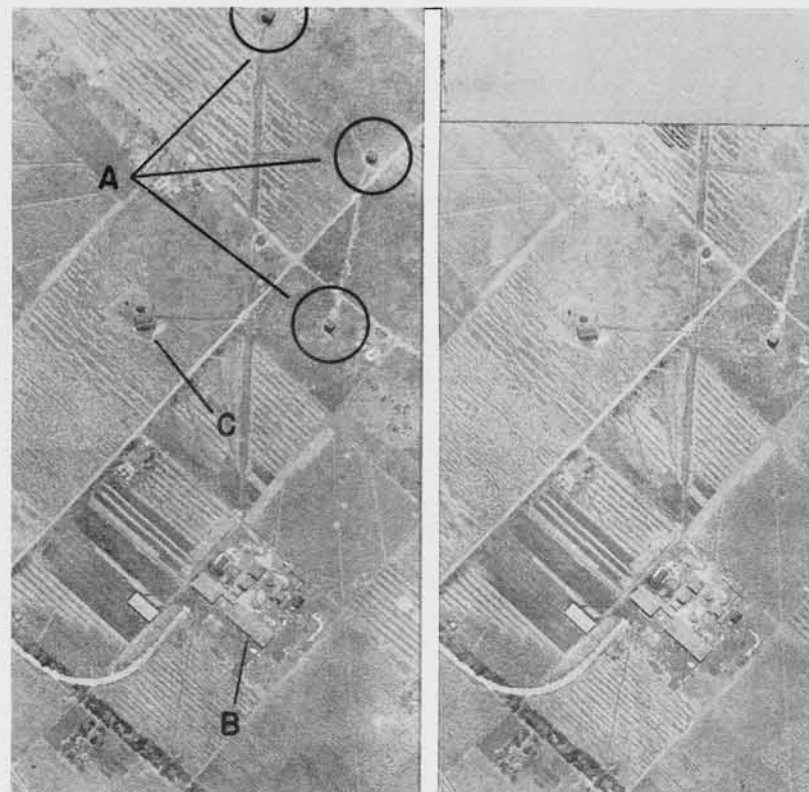
Type "5" similar to Majuro tower but without window sun shades. Roof is hipped and measures 23' x 23' in plan, including overhang.



(R.F. - 1/3500)

JALUIT, MARSHALLS

Vertical view of all three towers in the Jaluit Direction Finding Station. Note the "in line" pattern, road connection to all towers and probable generator building at left.



SAIPAN, MARIANAS

(R.F. - 1/6000)

- "A" - High Frequency D. F.
- "B" - D. F. Center
- "C" - Probable Generator Building

A High Frequency D.F. Station on Saipan. Complete with D.F. center and large (probable) generator building. It is more usual to find one or two Medium Frequency installations, in addition to the High Frequency towers, with this size station. Contents of "C" have not been reported as yet.



ULALU, TRUK

Type "4" tower with pitched roof and wooden sun shades. Note that road or path is always visible at operative stations.



TINIAN, MARIANAS

(R.F. - 1/2200)

Type "4" tower with hipped roof and wooden sun shades. The pattern on the roof presents an unusual appearance in this view.



VUNAKANA, RABAUL

Type "4" High Frequency D.F. tower with hipped roof at Rabaul. This is one of three which are used.

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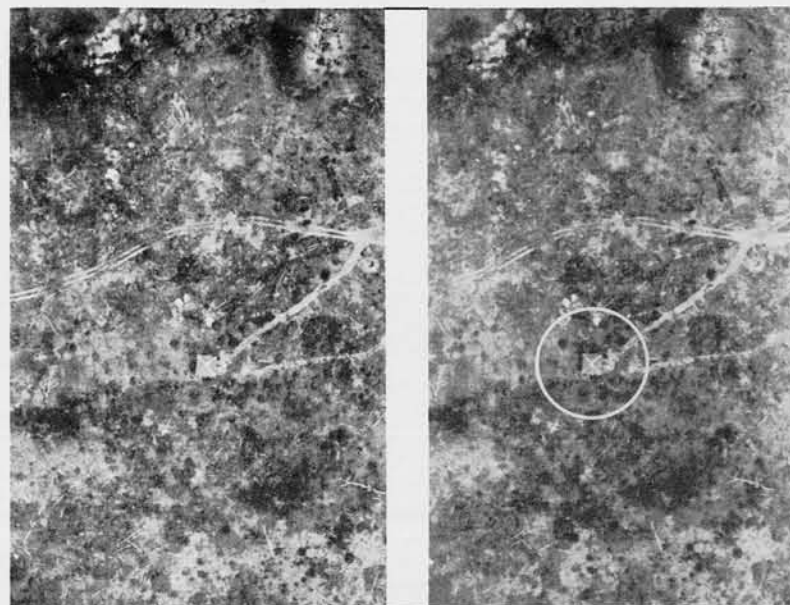
DIRECTION FINDING

HIGH FREQUENCY (CONT.)



WAKE

Tower on Wake, Type "I", was one of the earliest examples found of Japanese High Frequency D.F. towers. Note the absence of buttresses.



MILLE, MARSHALLS

(R.F. - 1/2600)

This installation at Mille is unusual in construction. The four rows of buttress type braced on each side have not been seen elsewhere. Apparently, construction was not complete when these pictures were taken.



ITUABA, TISSARD BANK

(R.F. - 1/4700)

It is difficult to determine the exact design of these towers due to the unusual shadow pattern. This equilateral triangle pattern is often found. Distance between towers is 350'.



WOTJE, GILBERTS

"A" - High Frequency D.F. tower
"B"-Probable Medium Frequency tower (loop type)



PALAU

"A" - High Frequency D.F. tower
"B"-Probable Medium Frequency tower (loop type)



PAGAN, MARIANAS

"A" - High Frequency D.F. tower
"B" Probable Medium Frequency tower (loop type)

These examples, at Wotje, Palau, and Pagan, illustrate a lower design of tower which is occasionally found with the 32' high standard tower. These low towers are approximately 22

feet high, from ground to roof eave, and probably enclose Medium Frequency loop type D.F. apparatus operating best between 100 and 2000 Kcs.

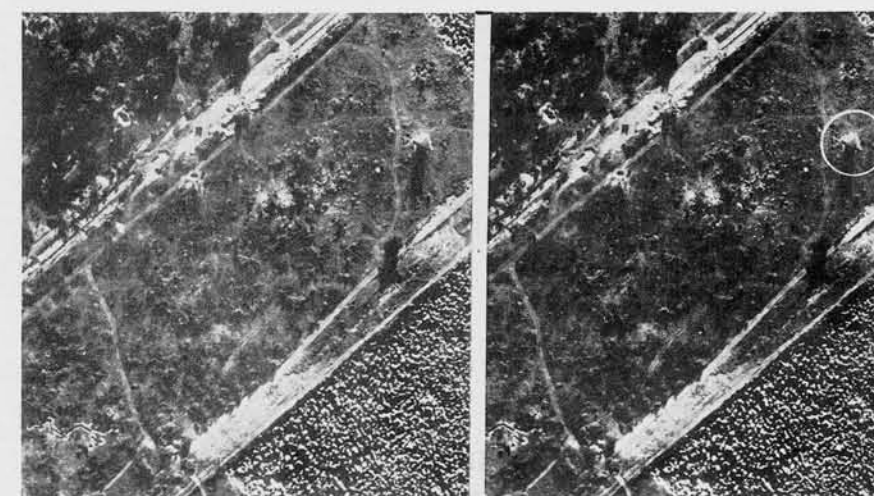
DIRECTION FINDING HIGH FREQUENCY (CONT.)



YUNCHENG, CHINA

(R.F. - 1/13000)

The installation shown above appears, at first glance, to resemble a fuel storage tank emplacement. However, upon closer examination, it is found to be a structure which resembles a typical D.F. tower, surrounded by a dike for protection against flood water.



NAURU

(R.F. - 1/5000)

Type "3" D.F. tower. Note single corner buttresses.



HANKOW, CHINA

(R.F. - 1/13000)

Probable High Frequency D.F. tower set in a square enclosure which appears to be a protective dike.

"A" - End of runway.

"B" - Unidentified tower, possibly High or Very High Frequency D.F.



CHICHI JIMA, BONIN IS.

"A" - Six high frequency D.F. towers

"B" - One Medium Frequency D.F.

This is one of the very few examples of a group of more than three D.F. towers on the same site. Normally, if more than three towers are used on an airfield, they are widely separated.

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DIRECTION FINDING

HIGH FREQUENCY (CONT.)

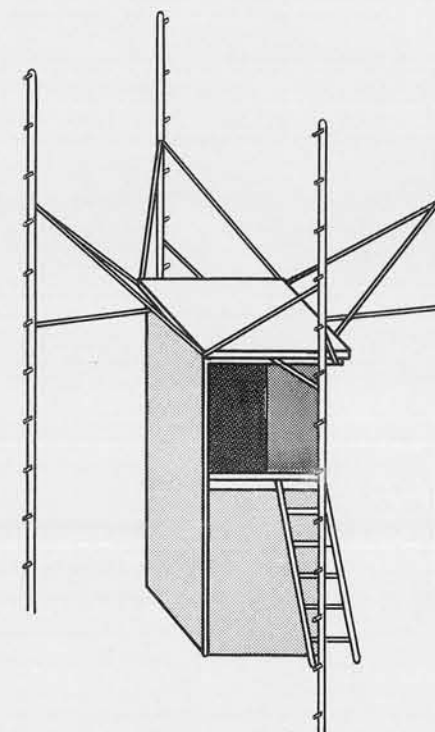


RAPOPO, NEW BRITAIN

This installation, observed at Rapopo and at Hollandia, is apparently a semi-portable type of High Frequency D.F. in the upper part of the High Frequency band.

The diagonal distance between poles is approximately 18 feet. Poles are 25 feet high. These are very difficult to pick up at small scale photography, the operator's tower being only 7 or 8 feet square in the plan view.

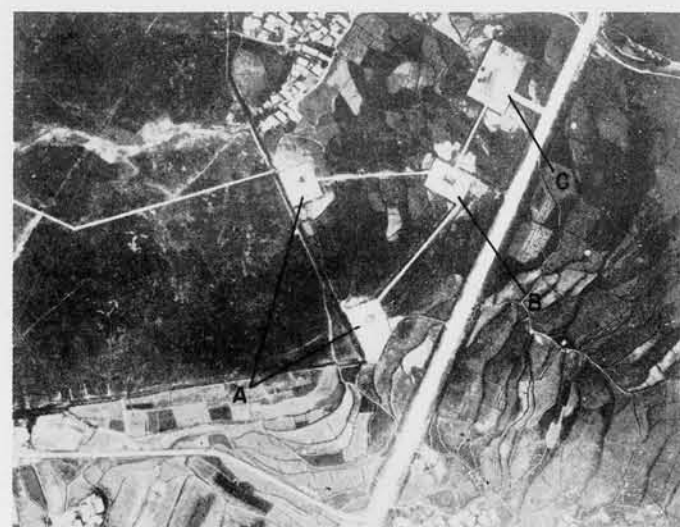
This structure is probably not a standard new type but a portable adaptation of the Mark I, Model 2 D.F. receiver as used in the "Housed Adcocks".



RIGHT: At Hollandia, three of these installations were used near the airfield in an irregular pattern, spaced a few hundred feet apart.



HOLLANDIA, NEW GUINEA



CHINKAI, KOREA

(R.F. - 1/6000)

This station in Korea contains (A) 2 High Frequency towers, (B) probable generator building, (C) D.F. center. The distance between towers is about 500'.

Patterns of arrangement may assume many different forms. However, road connections to the towers and cleared areas near the instrument create unmistakable patterns.

RIGHT: The D.F. center ("A") with this installation appears to be partially buried. The High Frequency towers are 1200' and 1800' apart.



PESCADORES IS.

(R.F. - 1/16250)

DIRECTION FINDING

MEDIUM FREQUENCY

The Japanese Medium Frequency (0.1 to 3 mcs.) Adcock type Direction Finder is shown on these and the following pages. It is designed for receiving and locating Medium Frequency transmitters.

Diagonal distance between unipoles	100'
Height of unipoles	60'-70'
Plan size of central shack	20' x 20'
Height of central shack (ground to eave)	8'
Plan size of concrete anchors (12 in no.)	3' x 3'
Average diameter of circular clearing	250'

This view shows clearly the Receiver Shack, covered cable connections, guy wires, and concrete anchors. The cable connections and concrete blocks are good recognition features at scales of 1/15000 and over, in cases where the poles are not readily seen.

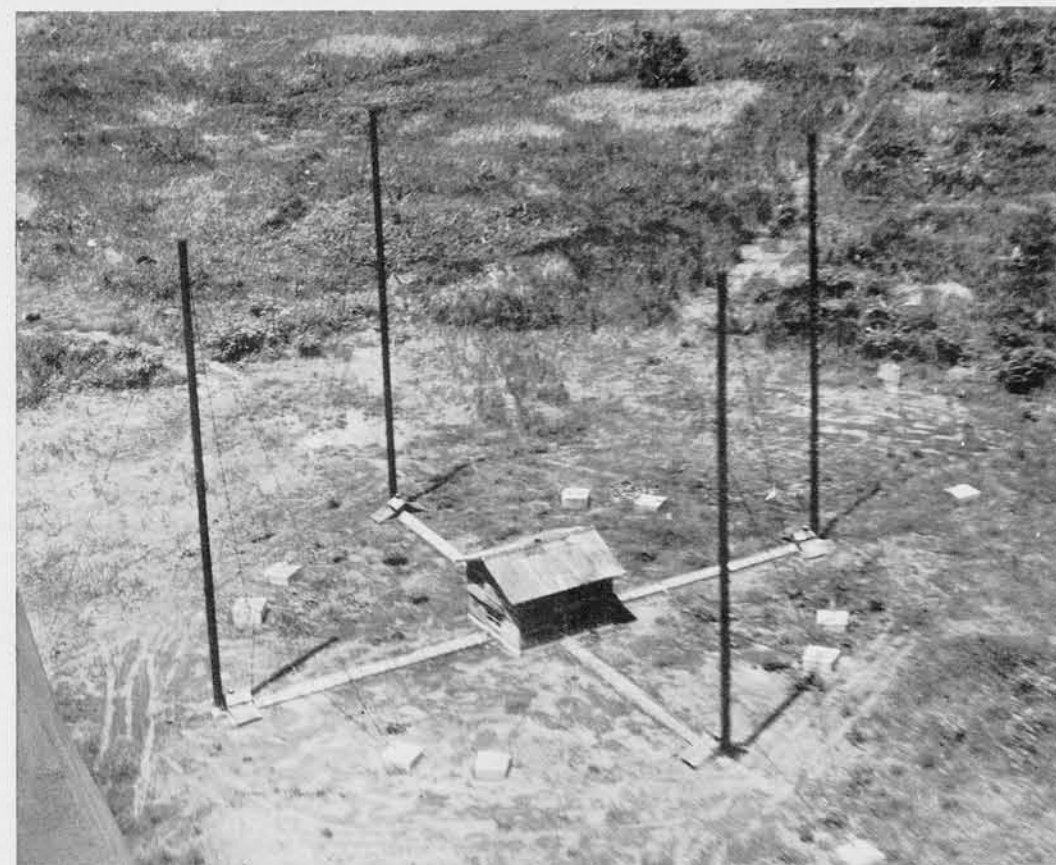
When a Medium Frequency D.F. is found, it will usually be accompanied by High Frequency towers. However, the reverse is not true, in that High Frequency towers are often found alone.

Recently, a rotating loop type D.F., such as is found on naval vessels (see page 3.04), has been discovered in use as a Medium Frequency land installation.

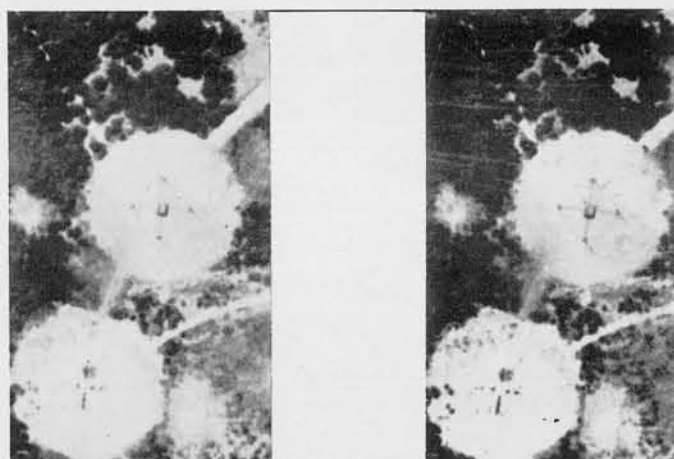
In this instance, the naval type loop was fitted into a wooden tower, resembling the standard Japanese High Frequency towers, but smaller. Tower was 12 feet square and 18 feet high.

The loops are slightly less than 3 feet in diameter and connected to a metal shaft leading down to the operator's table, 13 feet below the loop.

It is thought that this installation can D.F. on frequencies between 100 KCS and 2000 KCS, but is less efficient than the fixed Adcock type shown on this page.



VUNAKANAU, RABAUL, NEW BRITAIN



MARCUS

(R.F. - 1/3600)

Medium Frequency equipment is often found as twin installations. This setup at Marcus shows two unmistakable circular clearings of 250' diameter which characterize the Japanese Medium Frequency Adcock.



WAKE

(R.F. - 1/1800)

Note that the covered cable connections, in this case, photograph dark in tone. Pattern is made up of crossing cable lines, central shack, concrete anchors, poles and clearing (usually circular).



VUNAKANAU, RABAUL, NEW BRITAIN

View showing both of the medium frequency D.F. installations at the Vunakanau Airfield. Three high frequency towers (not shown here) are also present at this station.

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DIRECTION FINDER

MEDIUM FREQUENCY (CONT.)

Medium Frequency D.F. tower at Guam. Rotating loop, diameter 3 feet, is similar to type used on naval vessels.

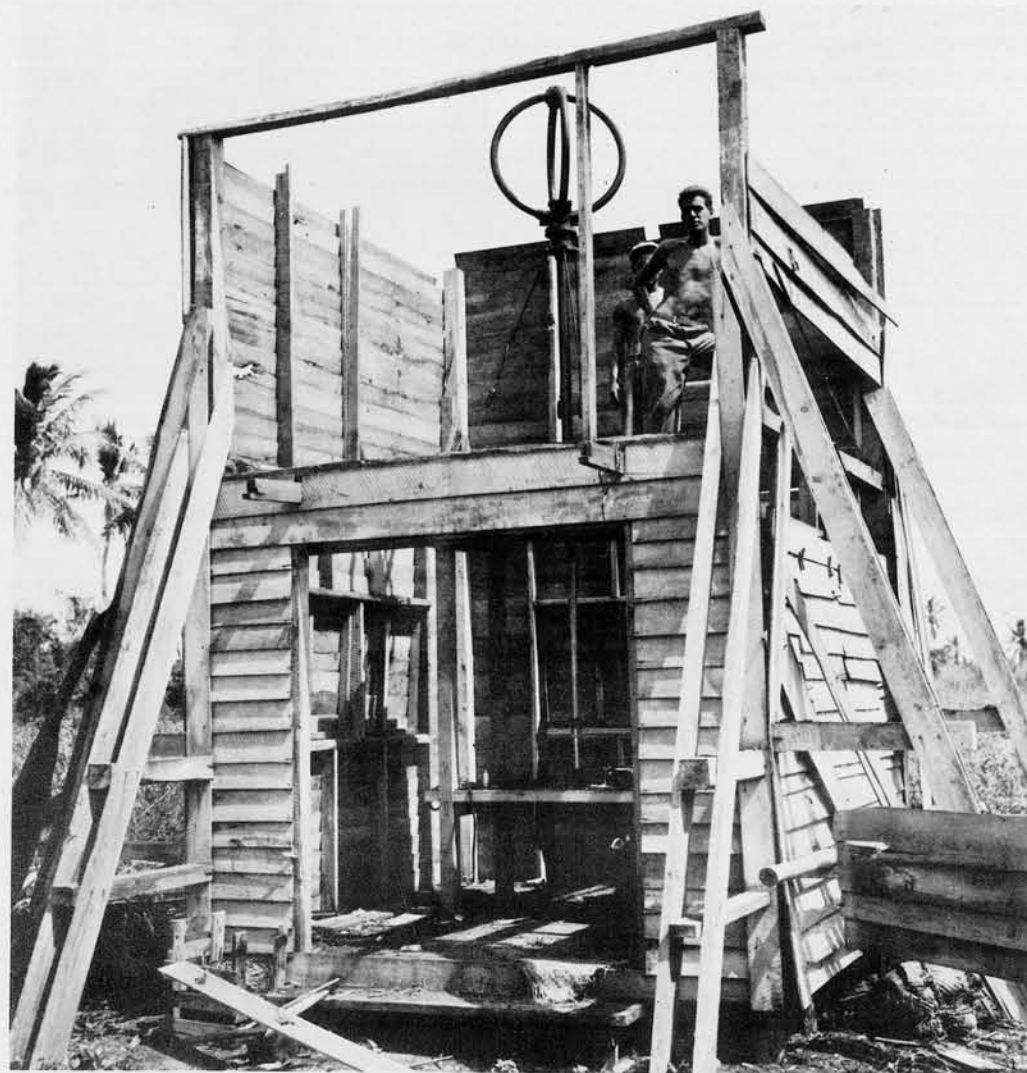
The 12 foot vertical shaft is of metal and its base is set on the operators table. The distance from the floor of the building to the top of the loop is 17 or 18 feet.

The building is 11'-12' square in plan view (minus buttresses) and was erected in a cleared area.

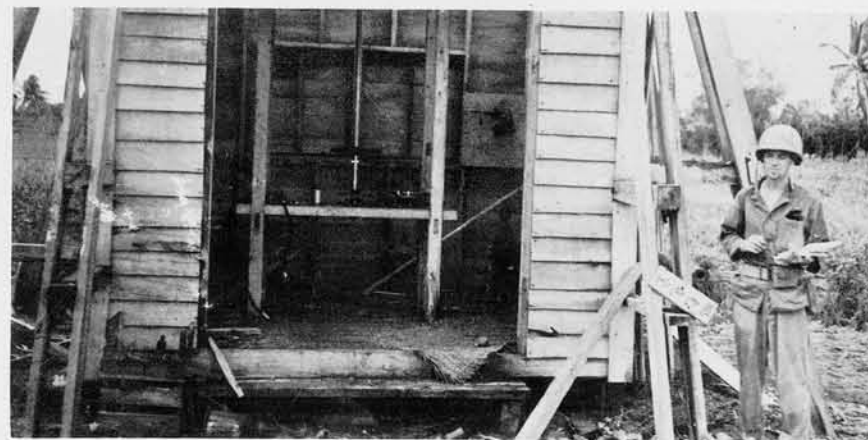
This building is very apt to be confused with the better known High Frequency D.F. tower, or "Housed Adcock". This type D.F. does not operate on the Adcock principle, however, and its loop is very probably constructed for receiving Medium Frequency signals.



M.F. LOOP TOWER



M.F. LOOP TOWER

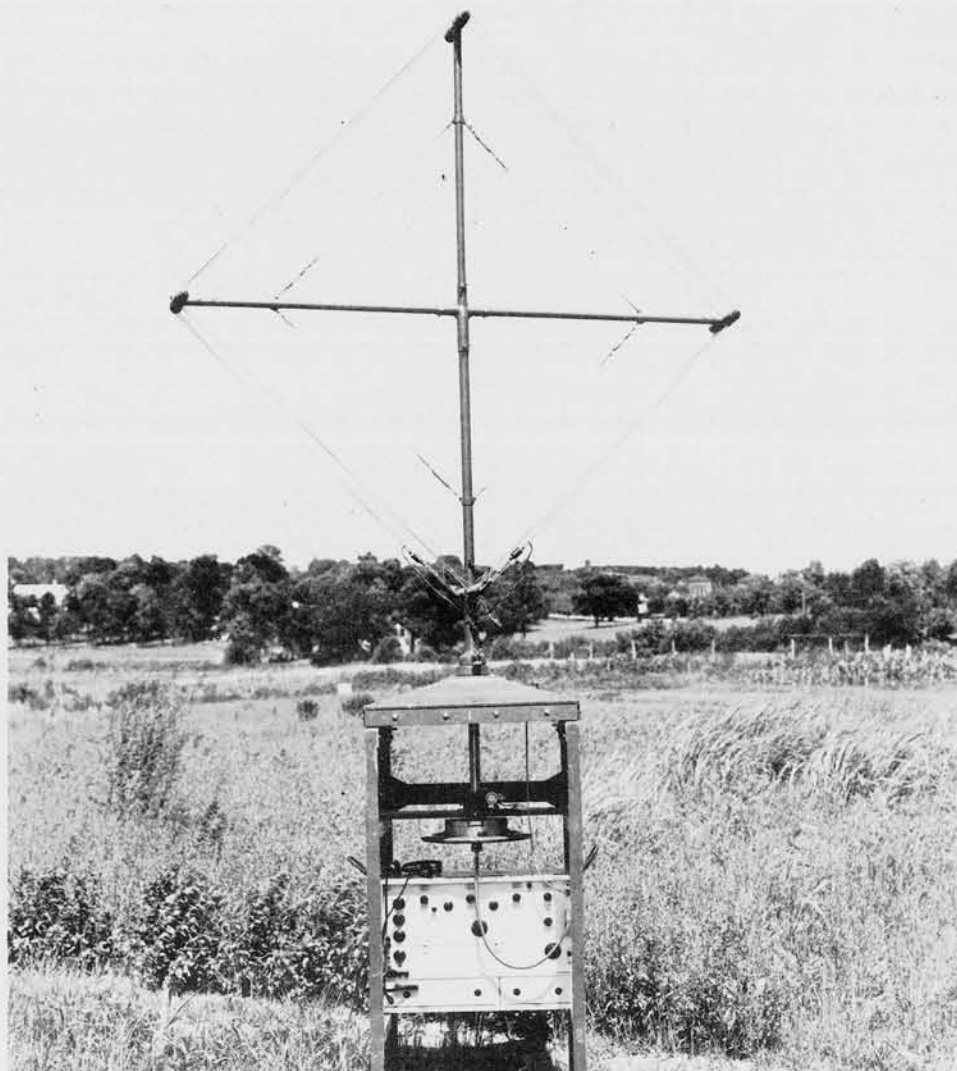


M.F. LOOP TOWER

DIRECTION FINDER

MEDIUM FREQUENCY (CONT.)

On this page are shown examples of three different types of Japanese Medium Frequency Direction Finders.



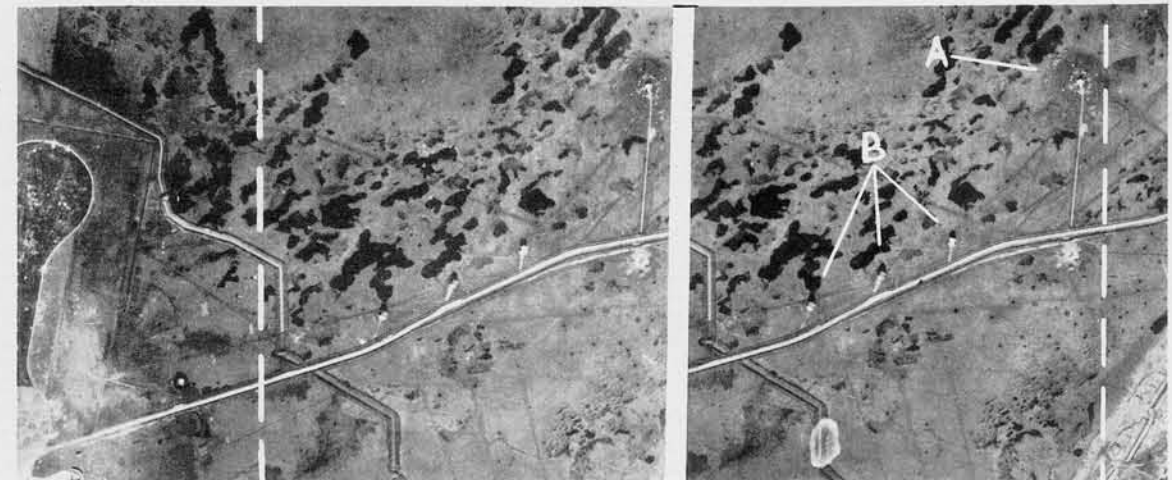
PORTABLE MEDIUM FREQUENCY D. F.

Japanese Army type Portable Medium Frequency D. F. The aerial, which measures 6 feet on the diagonal, rotates through 360 degrees. The installation is complete as shown in above photograph. Dry batteries are included with the receiver.

This D. F. is very similar to U. S. Army types of the year 1930.

The top of the antenna is 12 feet above the ground and the base is 2' x 2' x 5' high.

The receiver tunes between 100 and 2000 Kcs.



KURABU CAPE

(R. F. - 1/10000)

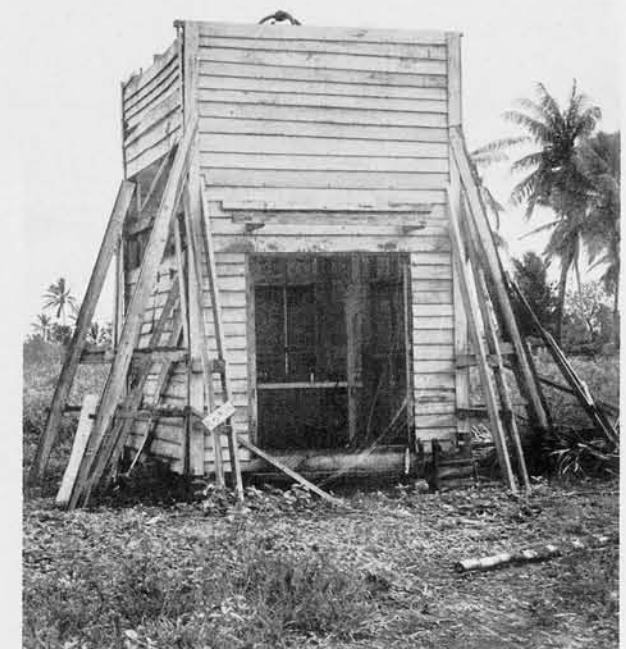
"A" - MEDIUM FREQUENCY ADCOCK D. F.

"B" - HIGH FREQUENCY D. F. TOWERS

Note that the most striking recognition features of the "Open Adcock" in this vertical compose a pattern made up of central shack, concrete anchors, and circular clearing.



M. F. LOOP



M. F. LOOP TOWER

The above pictures are of a housed Medium Frequency loop D. F. The loop is a Naval type.

CONFIDENTIAL

DIRECTION FINDING COMBINATIONS

On this page is shown a typical large D.F. station, containing 3 High Frequency towers and 2 Medium Frequency setups.

Most of the identifying characteristics mentioned in the previous pages are visible here. Most Japanese airfields have D.F. stations, and they are frequently found at the end of the runway as is shown in this example.

The High Frequency D.F. towers will tune between 3 to 30 megacycles per second. (3000-30000 Kcs.)

The Medium Frequency equipment will tune between 0.1 and 2 megacycles per second. (100-2000 Kcs.)

"A" High Frequency D.F.

"B" Medium Frequency D.F.

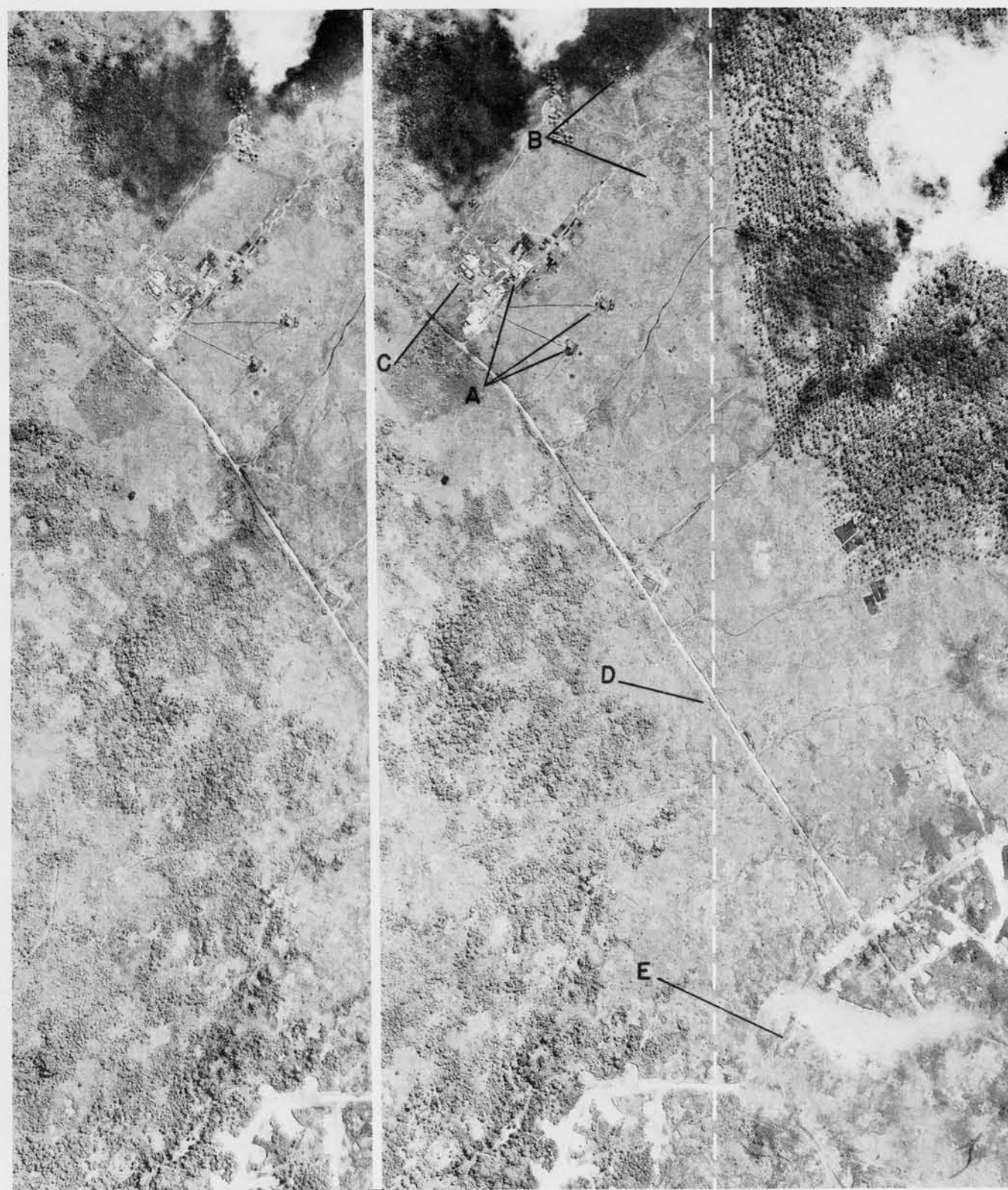
"C" D. F. Center

"D" Typical Connecting Road

"E" End of Runway.



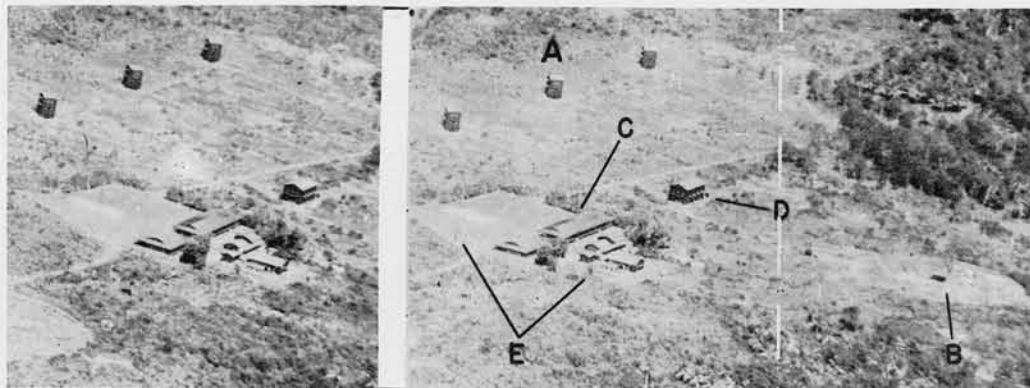
SIMPSON HARBOR, RABAUL



VUNAKANA, RABAUL, NEW BRITAIN

(R.F. - 1/10200)

DIRECTION FINDING COMBINATIONS (CONT.)



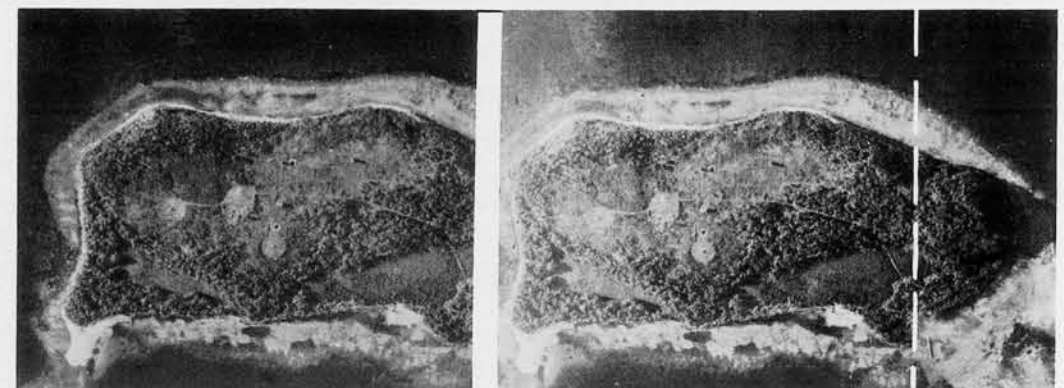
TRUK

Oblique stereo view of a typical large D. F. station capable of receiving at various frequencies between 0.1 and 30 megacycles per second.

- "A" High Frequency D. F.
- "B" Medium Frequency D. F.
- "C" D. F. Center
- "D" Probable Generator Building
- "E" Radio Reporting Station



TRUK

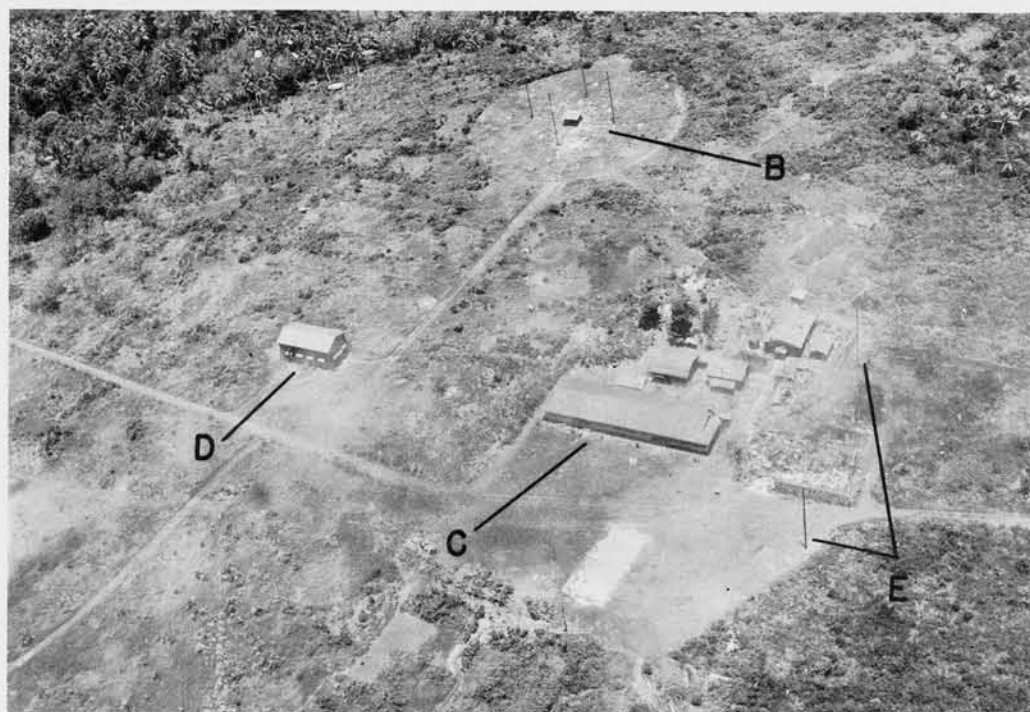


TRUK

(R.F. - 1/19700)

Vertical stereo view of Truk D.F. center taken after considerable bomb damage has been administered. Note that identification characteristics such as concrete anchors on Medium Frequency D.F. are visible even at this small scale.

The pattern of roads and paths is an integral part of D.F. station identification. Each installation requires at least one full time operator, hence traffic lanes to all sets are imperative. The High Frequency towers here are of type "4" design.



TRUK

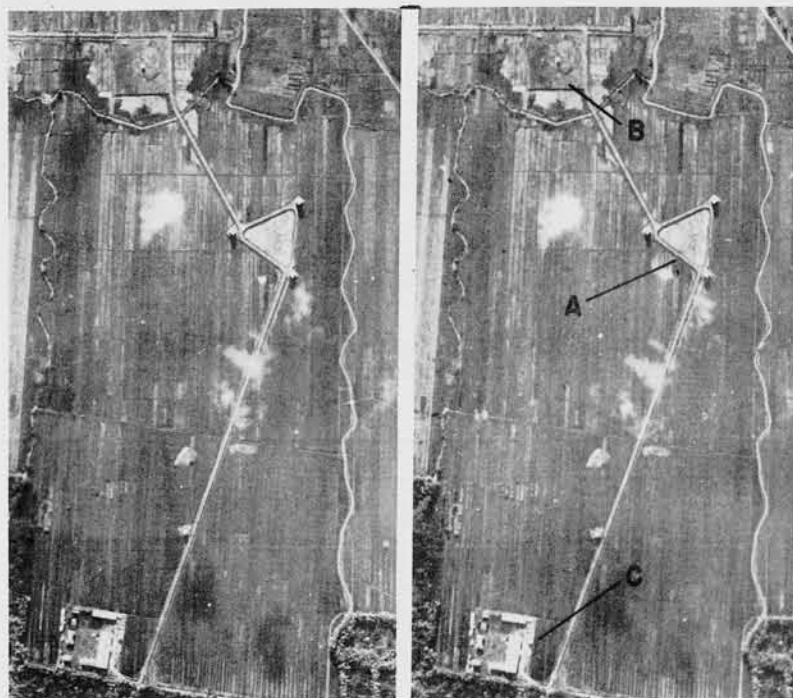


TRUK

CONFIDENTIAL

DIRECTION FINDING

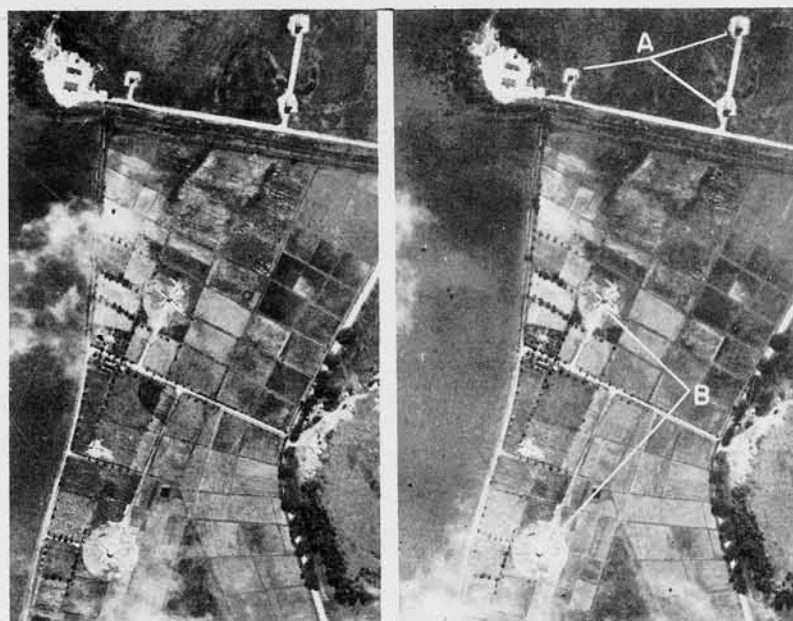
COMBINATIONS (CONT.)



SOERABAJA, JAVA

(R.F. - 1/10000)

BELOW: "A" - High Frequency D.F.; "B" - Medium Frequency D.F. Two of the High Frequency buildings appear to be of the type "8" design (see summary). Although this is known to be a standard type, Chaldari is the only example shown in this report.



CHALDARI, SO. ANDAMAN IS.

(R.F. - 1/9500)

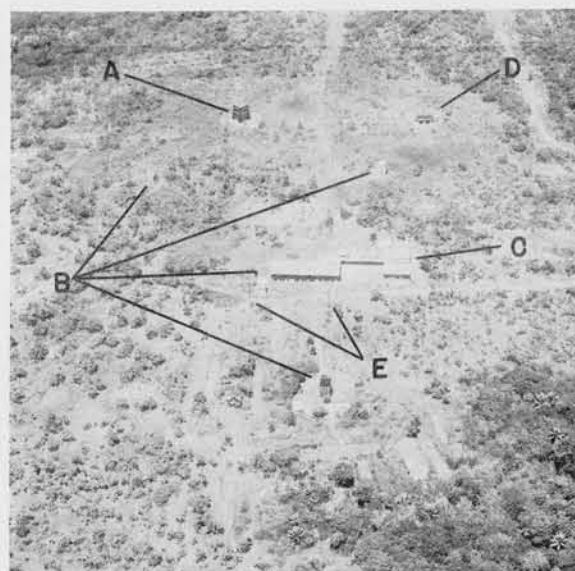
- "A" - Three High Frequency D.F.
- "B" - Two Medium Frequency D.F.
- "C" - D.F. Center

The towers here are arranged in an equilateral triangular pattern with 300 foot sides. The left stereo shows but one of the two

existing Medium Frequency installations. The low oblique shows the entire D.F. station and its relationship to the surrounding country. Flooded areas such as rice fields, afford good sites for all types of electronics equipment.

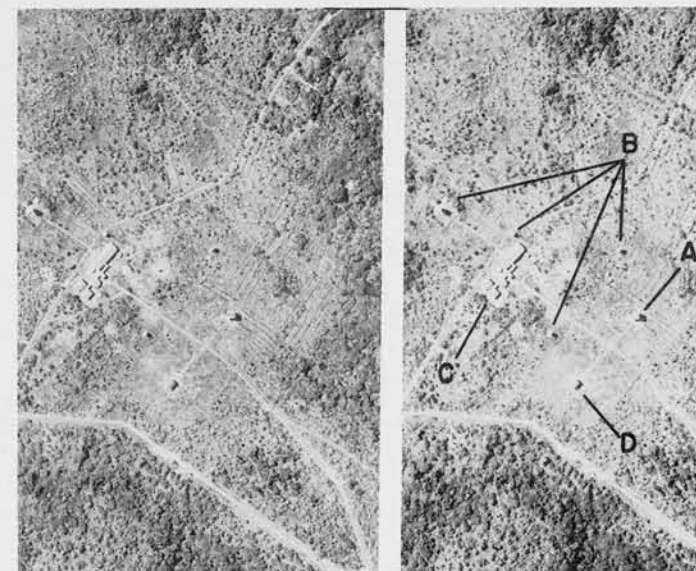


SOERABAJA, JAVA



YAP

- "A" - Type "5" D.F. tower (High Frequency)
- "B" - Towers, presumed to enclose loop type Medium Frequency D.F.

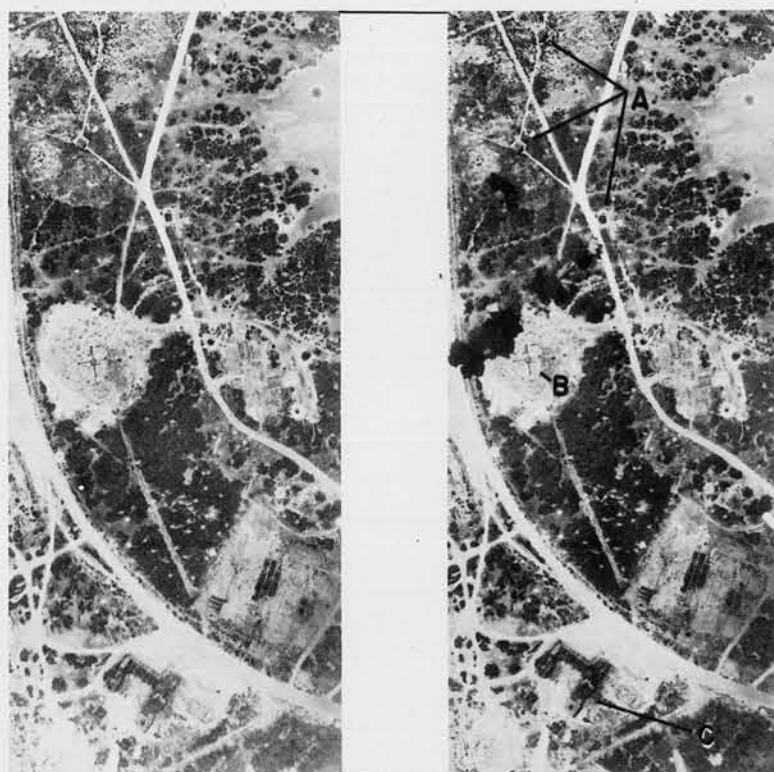


YAP

- "C" - D.F. Center
- "D" - Probable Generator Building
- "E" - Masts of Radio Reporting Station

(R.F. - 1/9000)

DIRECTION FINDING COMBINATIONS (CONT.)



WAKE

(R.F. - 1/7500)

LEFT:
D.F. center on Wake
"A" - Three type "I" High Frequency towers
"B" - One Medium Frequency DF
"C" - Attu type Radar on roof of former U.S. Bachelor Officers Quarters.

Radar is often found in conjunction with D.F. Stations.

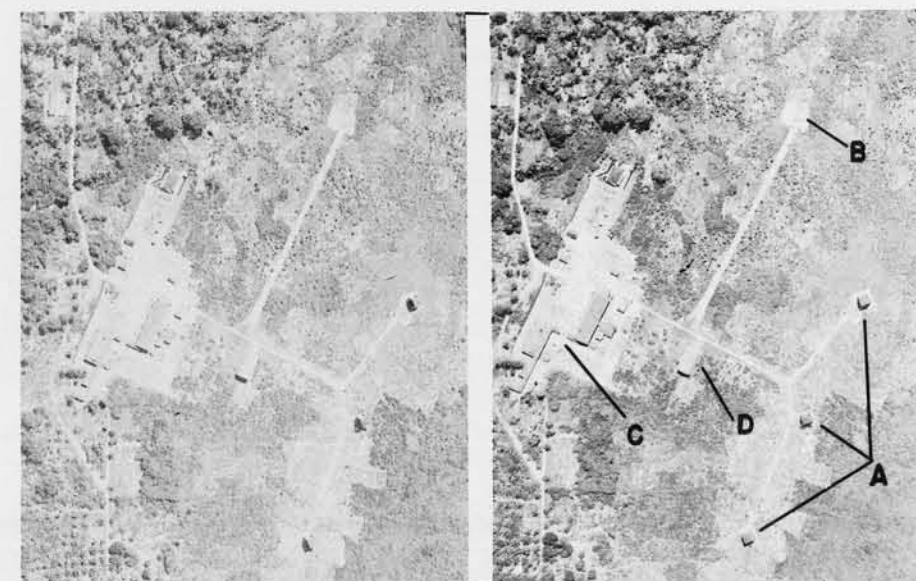
Note path and road connections to all D.F. installations

D.F. Center is probably across road to the right of Medium Frequency set.



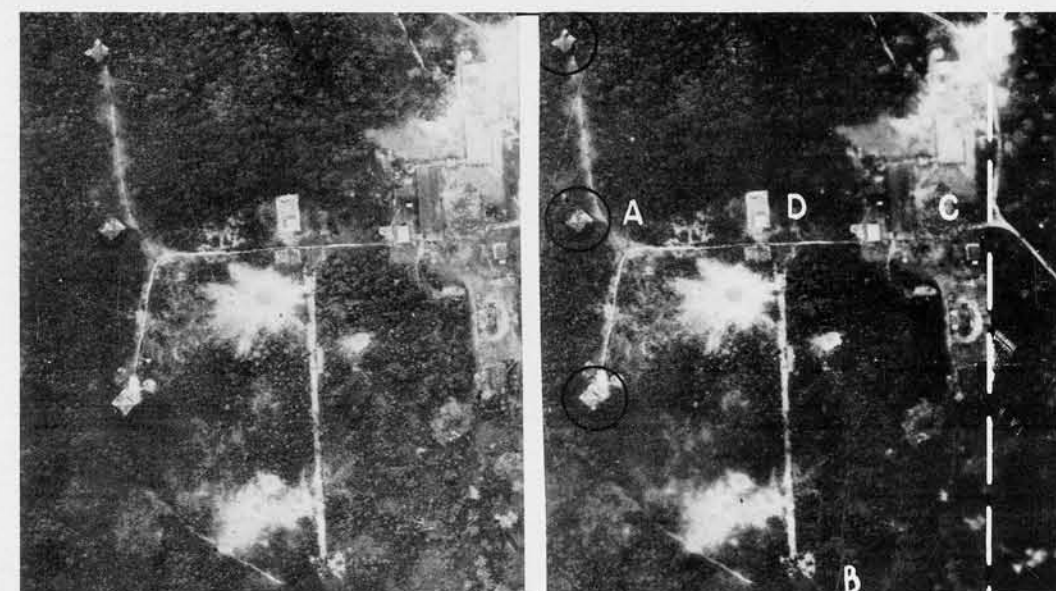
KOEPANG, TIMOR

"A" - TWO HIGH FREQUENCY D.F. TOWERS "B" - ONE MEDIUM FREQUENCY D.F.
"C" - D.F. CENTER WITH RADIO REPORTING STATION (MEDIUM FREQUENCY)
"D" - POSSIBLE HIGH FREQUENCY D.F. TOWER (NEWLY ERECTED - THIS DESIGN HAS NOT BEEN SEEN ELSEWHERE)



PALAU

(R.F. - 1/5000)



PALAU

(R.F. - 1/4000)

"A" - Three type "5" High Frequency D.F. towers
"B" - Site probably originally planned for Medium Frequency D.F.
"C" - D.F. Center
"D" - Probable Generator Building

The above two stereograms of the Palau D.F. station were taken several months apart. The lower one shows considerable bomb damage and some new construction. Apparently the Medium Frequency project was abandoned.

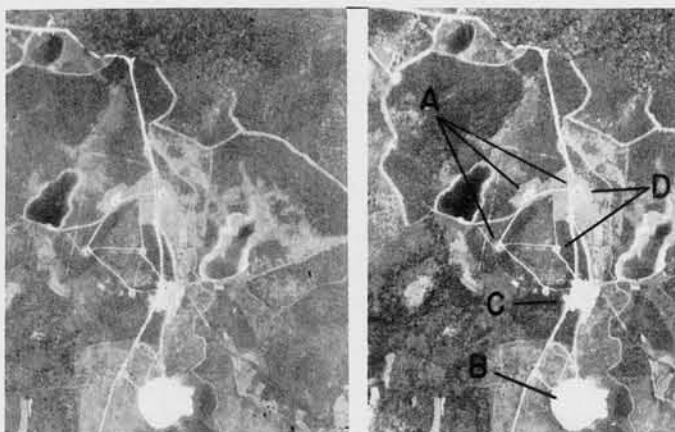
~~CONFIDENTIAL~~

DIRECTION FINDING

COMBINATIONS (CONT.)

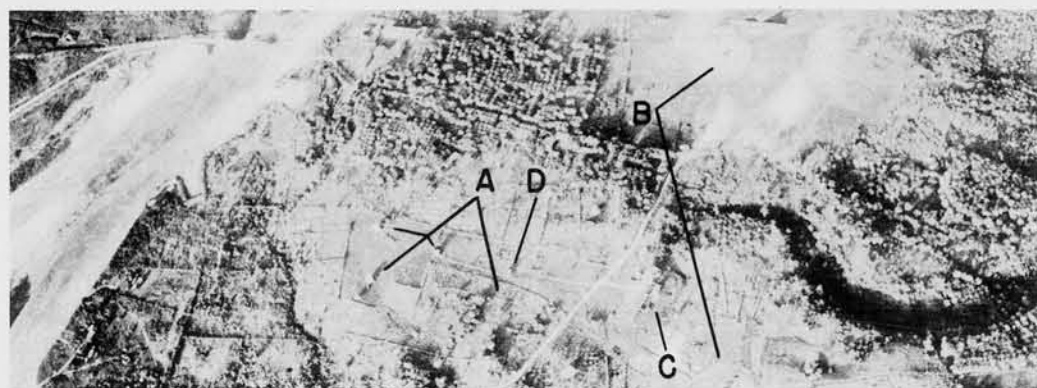
This is the first conclusive proof that the Japanese style of D.F., as standardized through the Pacific islands, is also used on the homeland in the same manner.

- "A" - Three High Frequency D.F. towers
- "B" - Medium Frequency D.F.
- "C" - D.F. Center
- "D" - Probable old type Medium Frequency D.F. such as type "8"



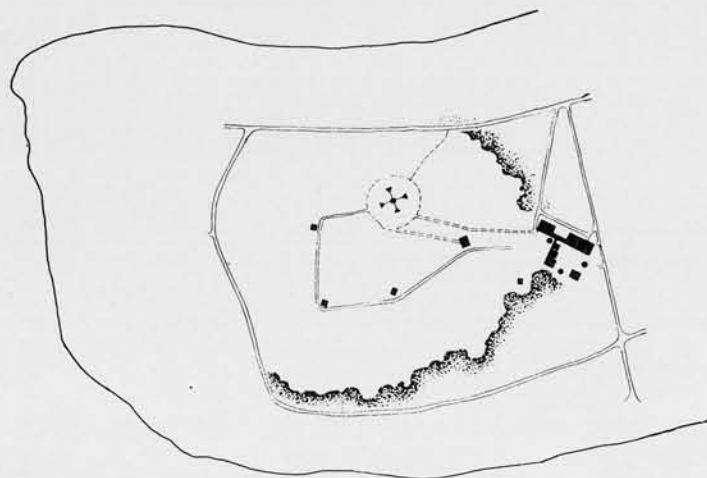
SASEBO, JAPAN

(R.F. - 1/16170)



SABANG, SUMATRA

- "A" - Three High Frequency D.F. towers
- "B" - Two Medium Frequency D.F.
- "C" - D.F. Center
- "D" - One Probable High or Very High Frequency tower (low type)

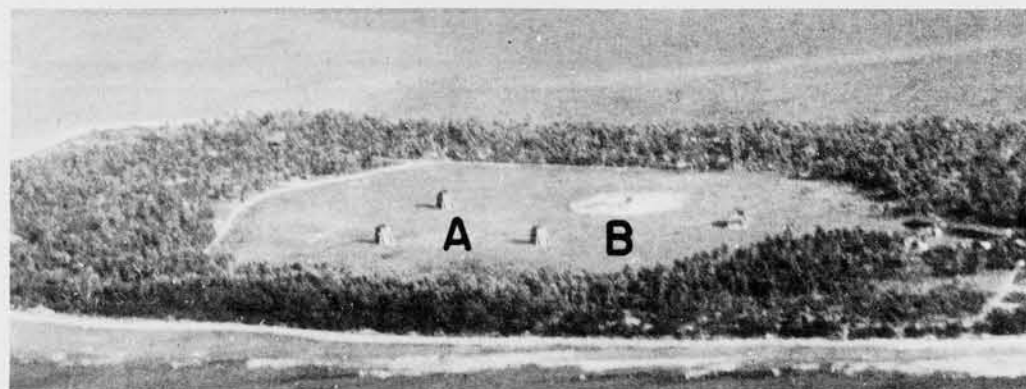


KWAJALEIN

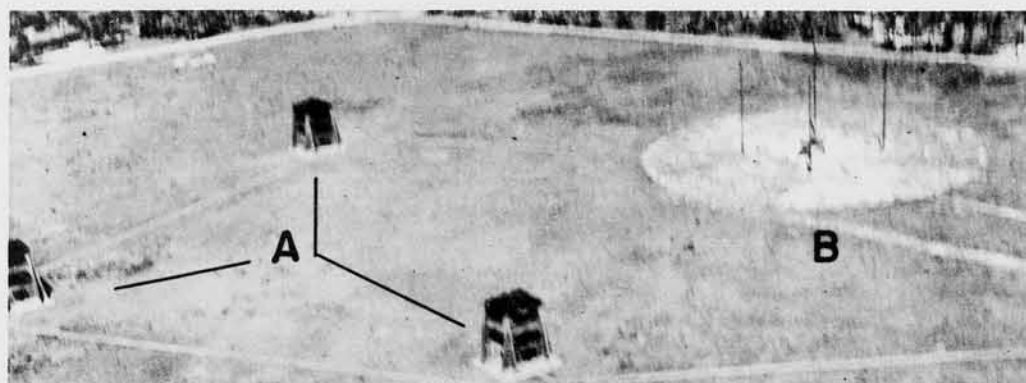


KWAJALEIN

(R.F. - 1/10000)



KWAJALEIN



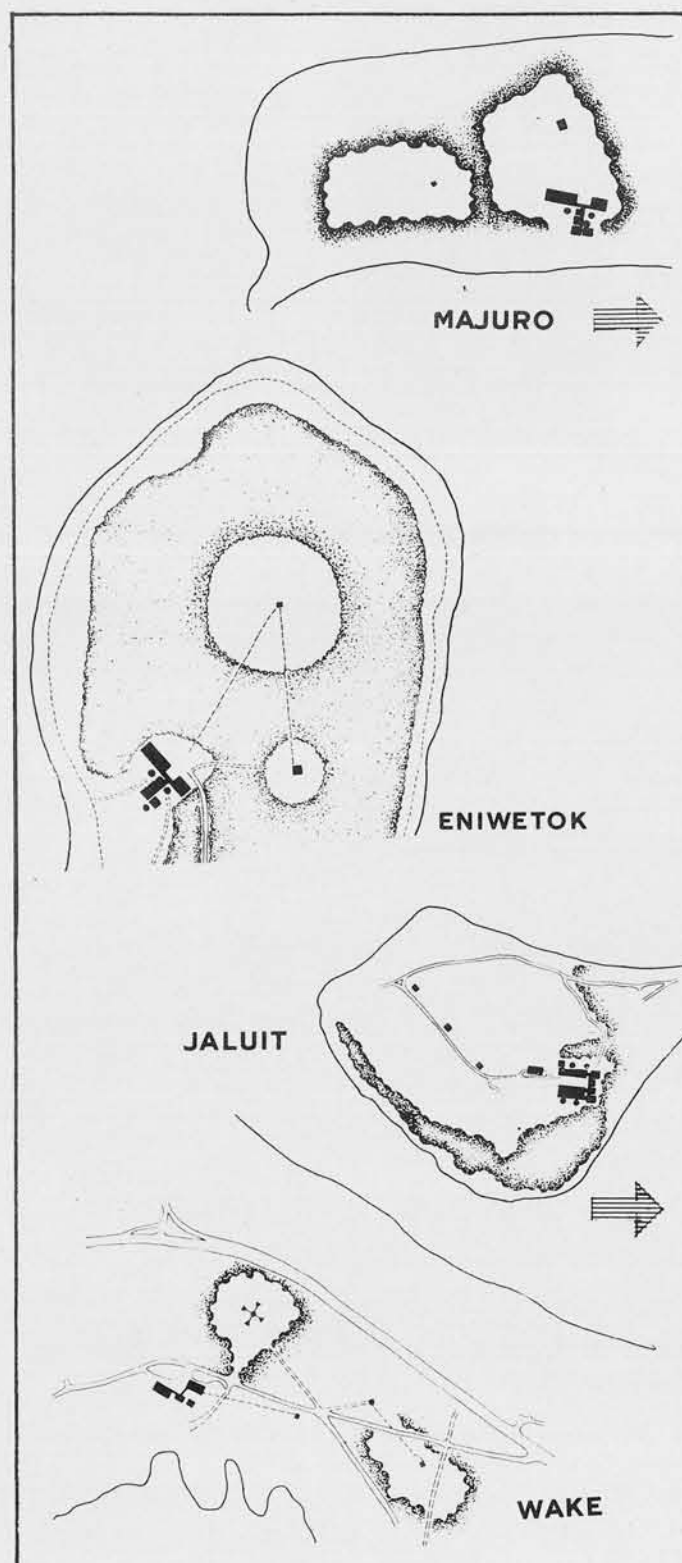
KWAJALEIN

- "A" - Three type "5" High Frequency D.F. towers.
- "B" - One Medium Frequency D.F.
- "C" - D.F. Center
- "D" - Probable Generator Building

One of the first Japanese D.F. stations observed was at Kwajalein.

Note constant orientation of all D.F. installations with respect to north.

DIRECTION FINDING CENTERS



Drawings of four D.F. stations showing the similarity in pattern and location of D.F. centers.



DARRITT, MAJURO, MARSHALLS

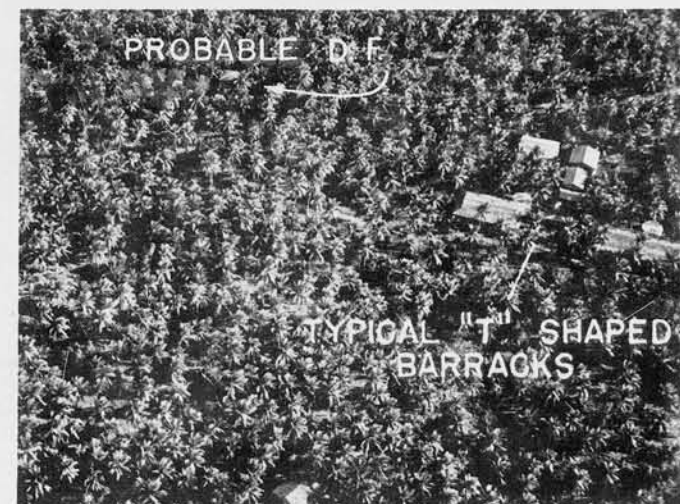
Japanese Direction Finder Stations often include a building group which is used for communications, administration and living facilities. Such a building group is here called a "D.F. Center".

The D.F. Center is easily recognizable by its pattern and location. In plan it assumes "T", "H", or "U" shape. It is usually composed of prefabricated wooden one story units connected by narrow covered passageways.



JALUIT, MARSHALLS

- "A" - MESS HALL OR BARRACKS
- "B" - LATRINE
- "C" - WASH HOUSE
- "D" - GALLEY
- "E" - WATER STORAGE
- "F" - OFFICES
- "G" - BARRACKS
- "H" - TRANSMITTING EQUIPMENT
- "J" - UNIDENTIFIED (PROBABLY FOR GENERATING POWER)
- "K" - MASTS FOR RADIO REPORTING STATION



UTIRIK

The largest elements of the building group are likely to be barracks or offices. The radio transmitter is often located at one end of the barracks building. This site should be cleared.



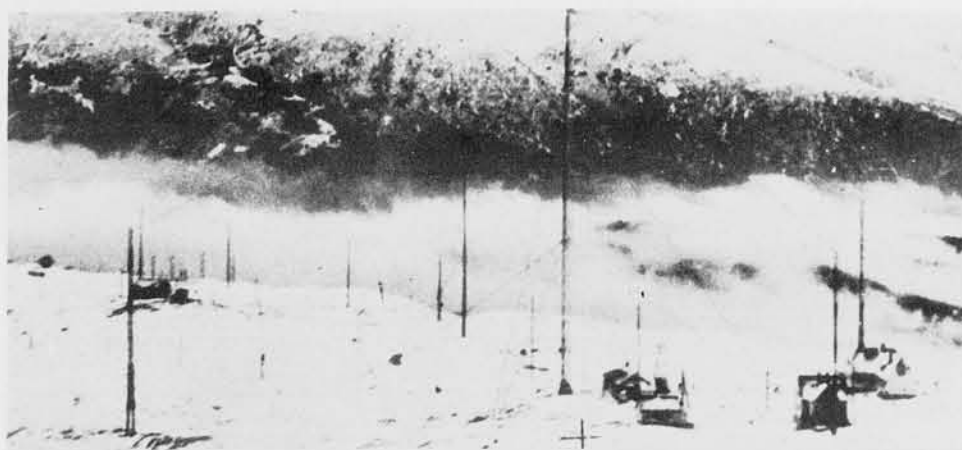
VUNAKANAU, RABAUL, NEW BRITAIN

- "A" - D.F. Center
- "B" - High Frequency D.F. Tower
- "C" - Mast for Radio Reporting Station

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DIRECTION FINDING

GERMAN



BELLINI - TOSI

The Bellini-Tosi D.F. consists of a tall central mast surrounded by four short masts which support aerials slung from the central mast. Since these feeds are above ground, no cross pattern is visible. The hut is slightly off center due to position of central mast. This is a loop type D. F.



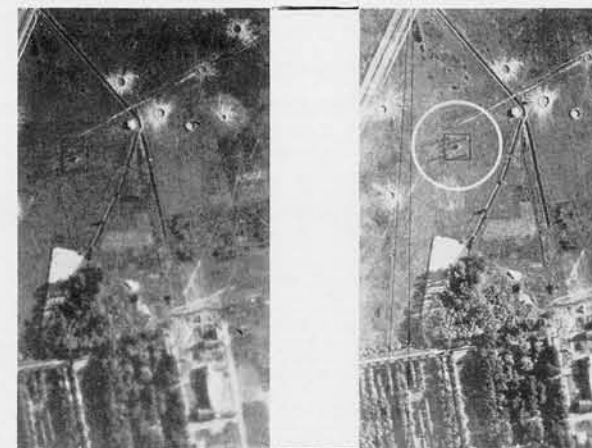
MEDIUM FREQUENCY ADCOCK

Identifying characteristics of the German Adcock are clearly visible in this low oblique: Four masts in square, central hut, and square fence enclosure. Mast on hut is a central sensing antenna and is frequently visible. White scar leading from outside fence is buried power cable.

Note that the mast is a more elaborate design than on Japanese Adcocks.

There are two types of Direction Finders used by the Germans, the Adcock and the Bellini-Tosi. The Adcock type is the more generally used.

RIGHT: German Medium Frequency Adcock D. F. resembles the Japanese type, except for the well standardized use of a square fence (or wall) enclosure around the installation. This is strongly visible in aerial photographs, as is the circular clearing around the Japanese "Open Adcock".



GERMANY

(R.F. - 1/10000)

MEDIUM FREQUENCY ADCOCK



HIGH AND MEDIUM FREQUENCY ADCOCKS VILLERS, FRANCE

"A" - German High Frequency Adcock. Diagonal spacing between unipoles is about 30 feet.

"B" - German Medium Frequency Adcock. Diagonal spacing between unipoles is about 100 feet. note shadow of central sensing antenna, which is seldom visible in Japanese installations.

"C" - Headquarters building including radio reporting station. Scars leading out from this building are buried power lines.

DIRECTION FINDING

GERMAN (CONT.)

German Pylon Stations are used in connection with Aircraft Control. They consist of a Benito D.F. and a Benito Transmitter (do not confuse with Benito Navigational Aid) and a plotting hut.

They function as follows: The rotating Adcock type D.F. (mounted on the pylon) receives signals from the aircraft at 38.4-40.4 mcs. Information on range and bearing thus received goes to the plotting hut. Instructions emanating from here are relayed to the transmitter hut which sends same back to the aircraft at 40.4-42.3 mcs.

The Pylon is about 65 feet high and the transmitter mast is about 90 feet high.

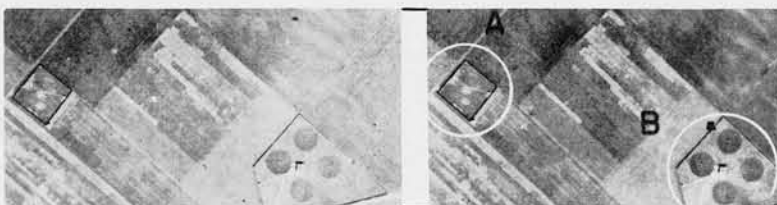
The typical Medium Range Benito station contains five D.F. pylons and five transmitters, all operating on slightly different frequencies for simultaneous control of five different aircraft.

There is a "short range" Benito set (not shown here) which is found on G.C.I. sites. It is similar but much smaller, the pylon and transmitter masts being but 25 feet high.



PYLON STATIONS

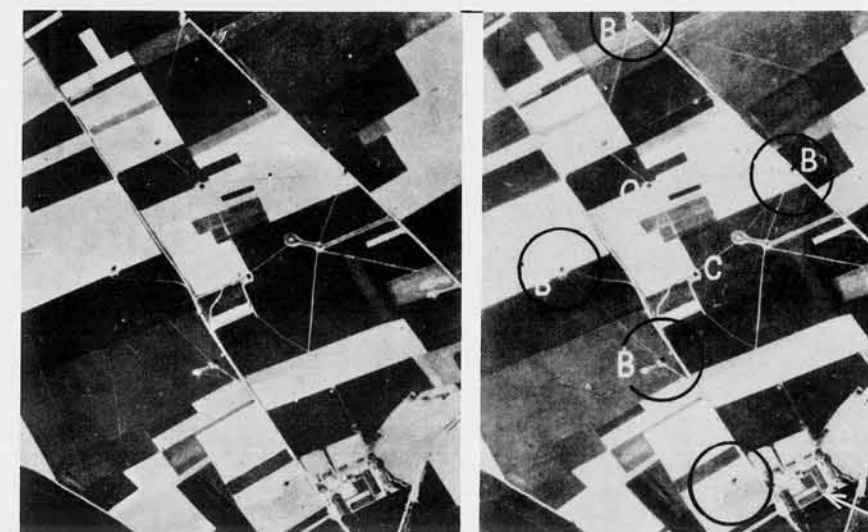
A. "T" hut, B. Pylons, C. Transmitter huts.



ADCOCK D.F.'s

(R.F. - 1/4500)

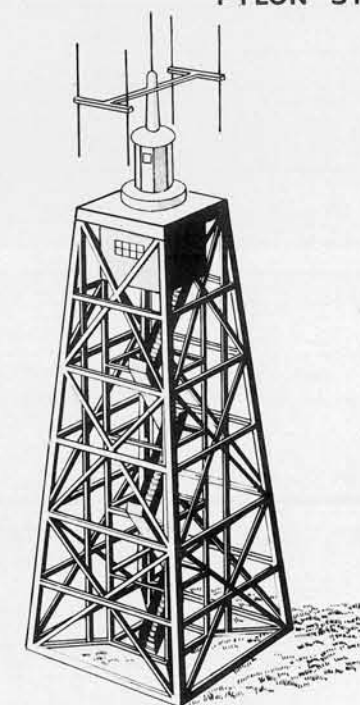
Left: "A" - Medium Frequency, "B" - High Frequency. Both of these installations are of the fixed Adcock type. Note that High Frequency collectors are in the open rather than housed, as in Japanese types.



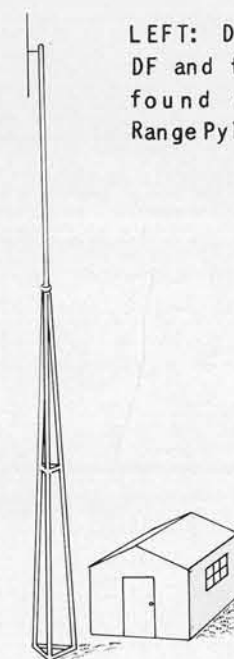
PYLON STATIONS A. "T" hut, B. Pylons, C. Transmitter huts.



PYLON STATIONS



MEDIUM RANGE BENITO
D.F. RECEIVER PYLON



MEDIUM RANGE BENITO
TRANSMITTER HUT AND MAST

LEFT: Drawings of
DF and transmitter
found in Medium
Range Pylon Stations

CONFIDENTIAL

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-4

4.01 — 4.99

NAVIGATIONAL AIDS

NAVIGATIONAL AIDS SUMMARY

Navigational aids, which are TRANSMITTERS of radio beams, are dealt with in this section. Included in this category are terms such as radio beacons, beam transmitters, navigational beams, and radio stations. (Direction Finders, which are also used as aids to navigation are included only under Section 3.)

PURPOSES

There are two primary purposes for navigational aids:

1. To guide ships or aircraft home to their base.
2. To guide aircraft to a bombing target.

INTERPRETATION

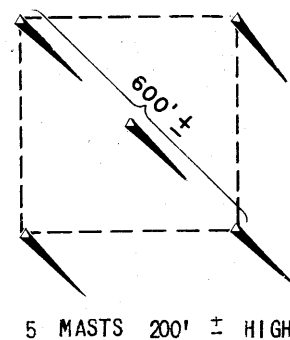
Navigational aids are difficult to interpret from aerial photos, primarily because of the large variety of possible shapes, patterns and sizes such installations may assume.

Although the Germans have standardized certain very high frequency navigational aid equipment (such as the Knickebein), Japanese installations that have been positively identified do not appear to be standardized as to type.

JAPANESE NAVIGATIONAL AIDS

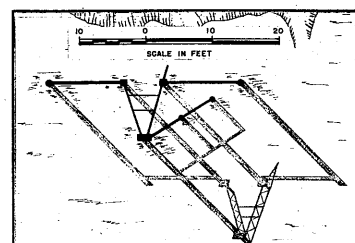
1. RADIO RANGE STATIONS FOR AIRCRAFT

These stations operate normally at between 100 and 300 Kcs. and require no equipment in the plane other than the usual radio receiver. From them one or several beams may be directed to any point of the compass. Reliable distance range would be from 200 to 400 miles.



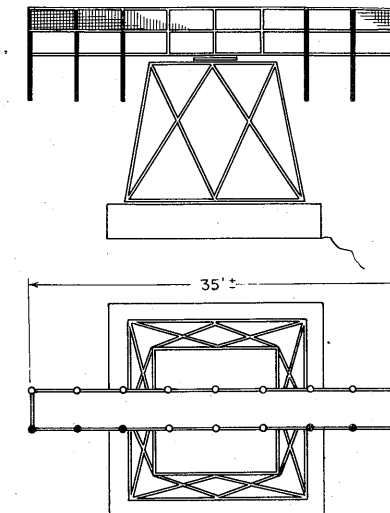
2. KISKA NAVIGATIONAL AID FOR SHIPS

This installation, the only one of its kind found to date, is apparently a makeshift arrangement and is of poor design. It operates at 60 to 70 Mcs. and has effective distance range of approximately 100 miles.



3. CHICHI JIMA NAVIGATIONAL AID FOR SHIPS

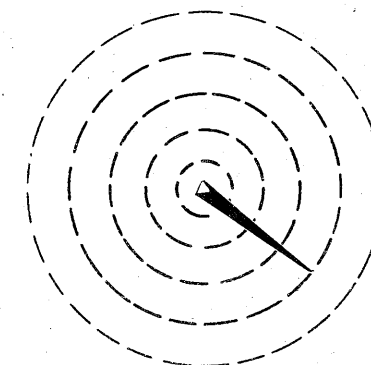
Recently a suspected navigational aid which commands the entrance to the harbour of Chichi Jima, Bonins, has been photographed. If a navigational aid, this installation is probably used for guiding ships at sea.



Note: No other types of Japanese Navigational Aids are known to have been identified from photos (except for communications stations) up to date of publication.

SINGLE RADIATING LATTICE MAST FOR AIRCRAFT

A single radiating mast may serve as an air navigational aid having no directional capacities in itself. Such an installation may send out a beam covering a circular pattern with the mast in the center.



When an aircraft comes within this area of signals, D.F. equipment in the plane itself will home the plane.

Note: Any single lattice mast is suspected of being an air navigational aid, even though it may not function in the manner shown above.

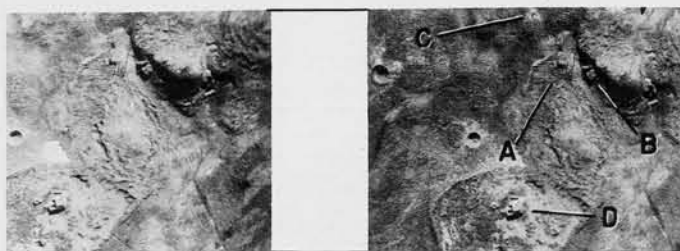
SIGNALS

Final identification of a Navigational Aid will best be accomplished by checking carefully against any signals that may have been recorded from the area being interpreted-

RESTRICTED

NAVIGATIONAL AIDS

JAPANESE



KISKA

- "A" - NAVIGATIONAL AID
 "B" - DUGOUT FOR GENERATOR
 "C" - MONITOR RECEIVER
 "D" - PERSONNEL HUT

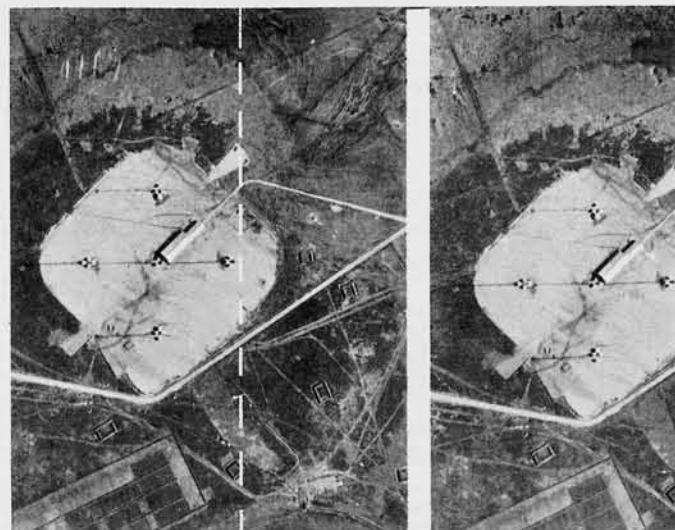
(R. F. - 1/5200)



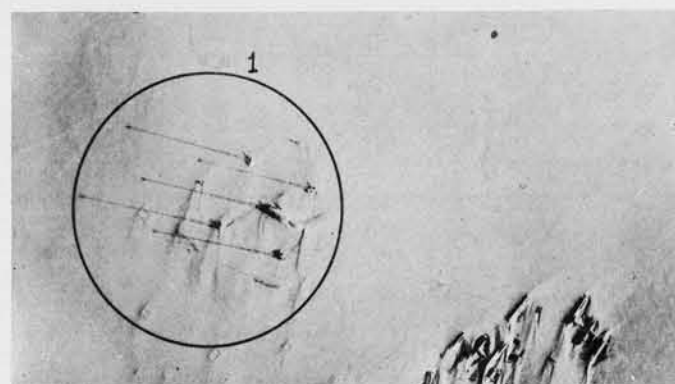
KISKA

The above radio navigational aid, found at South Head, Kiska, was the first Japanese aid captured in this war. Its purpose was to guide ships at sea. This installation is of makeshift nature and is not an efficient electronics device. It is unlikely that the design will be found again. The reflectors are 29 feet long and are set 20 feet above ground level. It operates at a frequency of 70 mcs. Code beam switching, similar in principal to "A and N" is used.

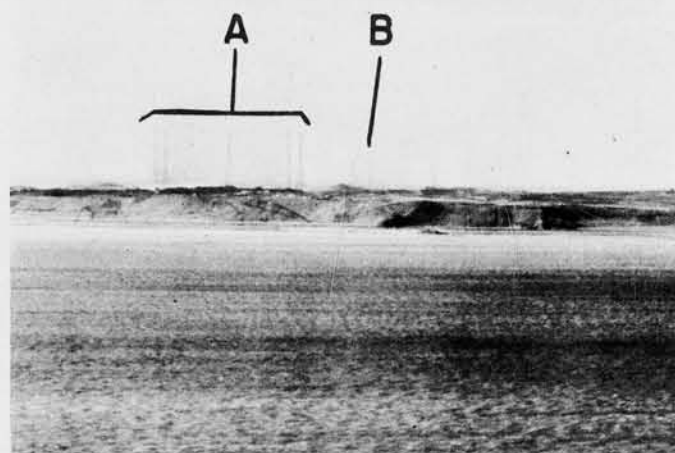
RIGHT: Five mast Radio Range Station at Kurabu Cape, Paramushiro, is very similar to peace time "beam" stations for aircraft. The masts are about 200 feet high and the circular forms at top indicate that they are "top-loading" radiators. The diagonal distance between masts is approximately 600 feet which would indicate frequencies between 200 and 400 Kcs. Radio Range Station.



KURABU CAPE

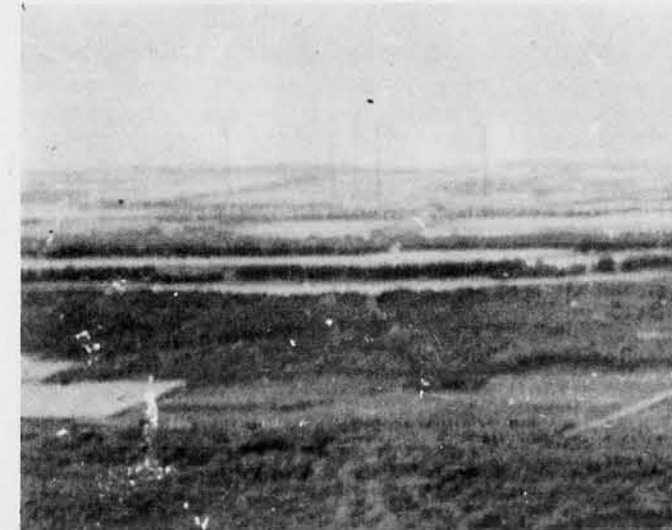


KURABU CAPE



KURABU CAPE

- "A" - RADIO RANGE STATION
 "B" - MEDIUM FREQUENCY COMMUNICATIONS STATION



TINIAN, MARIANAS



TINIAN

ABOVE: Two views are shown of another Japanese Radio Range Station at Tinian. This pattern of five masts with a diagonal distance of 600 feet is characteristic of Radio Range Stations. This is an air navigational aid.

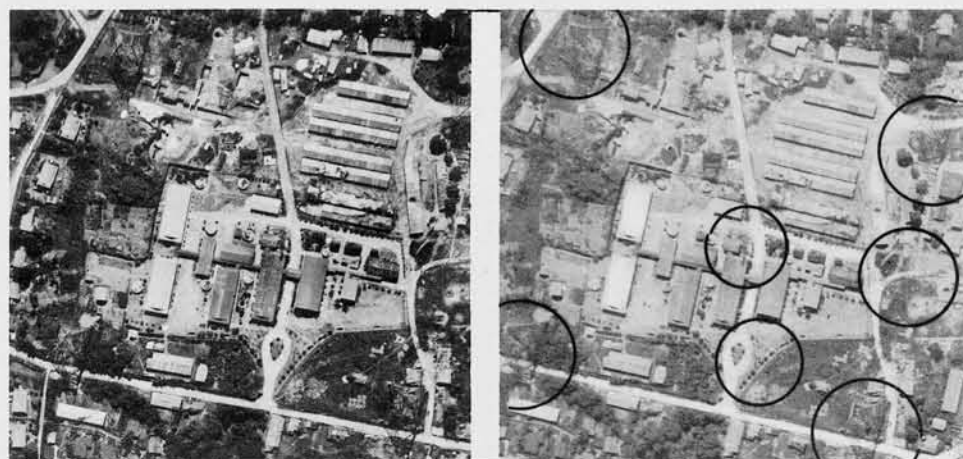
The advantages of low frequency navigational aids of this type are as follows:

- (a) Long range and reliable
- (b) No special equipment necessary in plane. Usual radio receiver will act in place of direction finders etc.
- (c) May exist from peacetime construction period.

Frequency is usually between 200 and 400 Kcs.

NAVIGATIONAL AIDS

JAPANESE (CONT.)



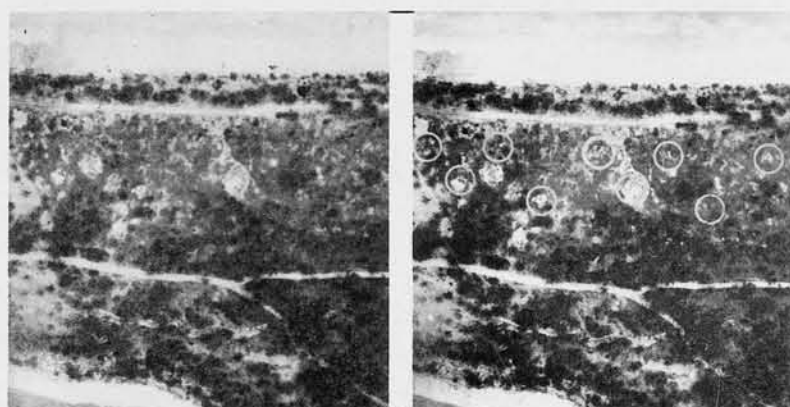
PALAU

(R.F. - 1/4800)

Pre-war Low Frequency Radio Station at Palau which may have facilities for sending a navigational beam for aircraft. The lattice masts are 300 feet high and set in a square pattern with a diagonal distance of 1000 feet.

The stick masts, added recently, are about 100 feet high and are undoubtedly for communications.

There is apparently a small lattice mast in the center of the square pattern of large masts, which would lend support to the thesis that the station could be used for sending a navigational beam.

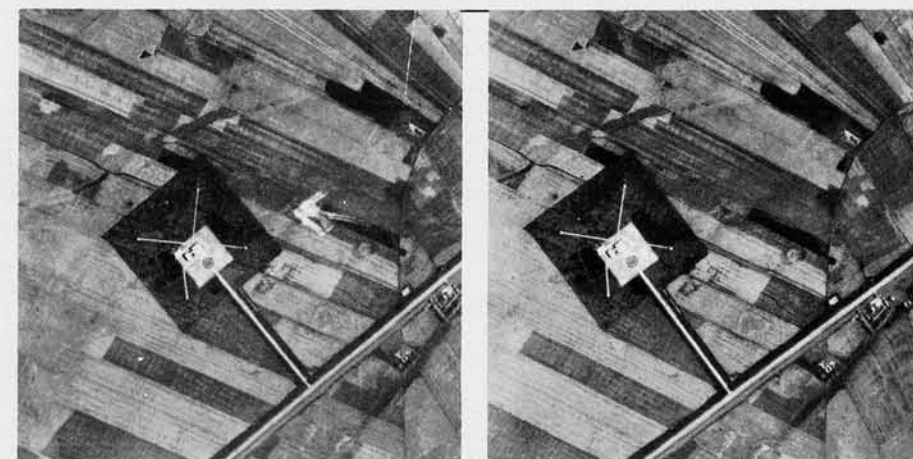


MILLE, MARSHALLS

ABOVE: Stereogram of possible Air Navigational Aid at Mille showing all nine spliced wood stick masts.

A similar mast pattern is also used for directional transmitting and receiving of communications, and it is possible that this may be an intercept station.

A three mast medium frequency communications station is just off the picture to the lower left.

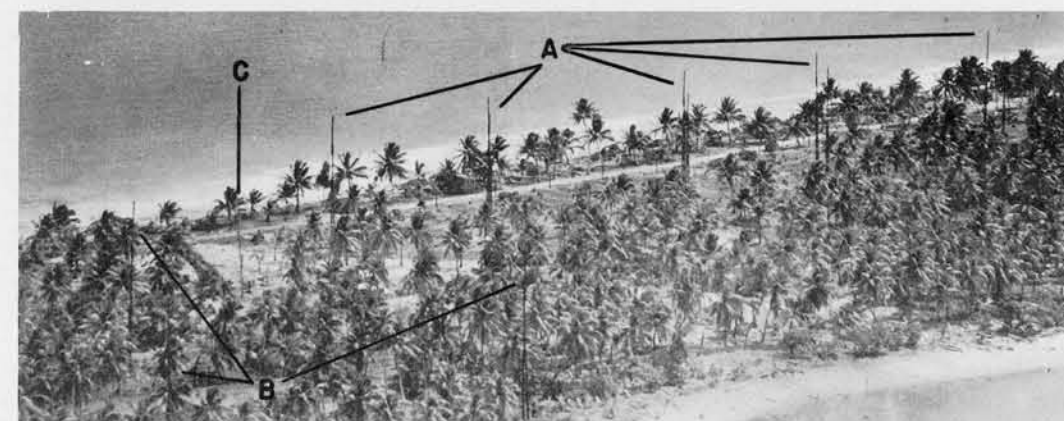


BANKOK, THAILAND

(R.F. - 1/14000)

This installation at Bangkok is unusual in that, excepting for size, it looks like a D. F.

However, the masts, which are over 200 feet high, are 5 in number and arranged in a radio range station pattern with a diagonal distance of 600 feet, which would be suitable for sending a beam at frequencies between 200 and 400 Kcs. for guiding aircraft. It is unlikely that D. F. equipment would have such large dimensions, for it would indicate reception of low frequency whereas the need for D. F. on low frequency is slight.



MILLE, MARSHALLS

- "A" - 9 STICK MASTS, 75 FEET HIGH
- "B" - 3 STICK MASTS, 75 FEET HIGH, FOR COMMUNICATIONS
- "C" - POWER OR COMMUNICATIONS LINES

Three views of an unidentified installation on Mille, which is thought to be an air navigational aid.

The installation consists of nine type "5" spliced wood stick masts (see page 2-03) arranged in a staggered pattern along the shore.

Note pattern in vertical stereogram. These nine masts are guyed from the top, whereas the communications masts are not.

NAVIGATIONAL AIDS

JAPANESE (CONT.)

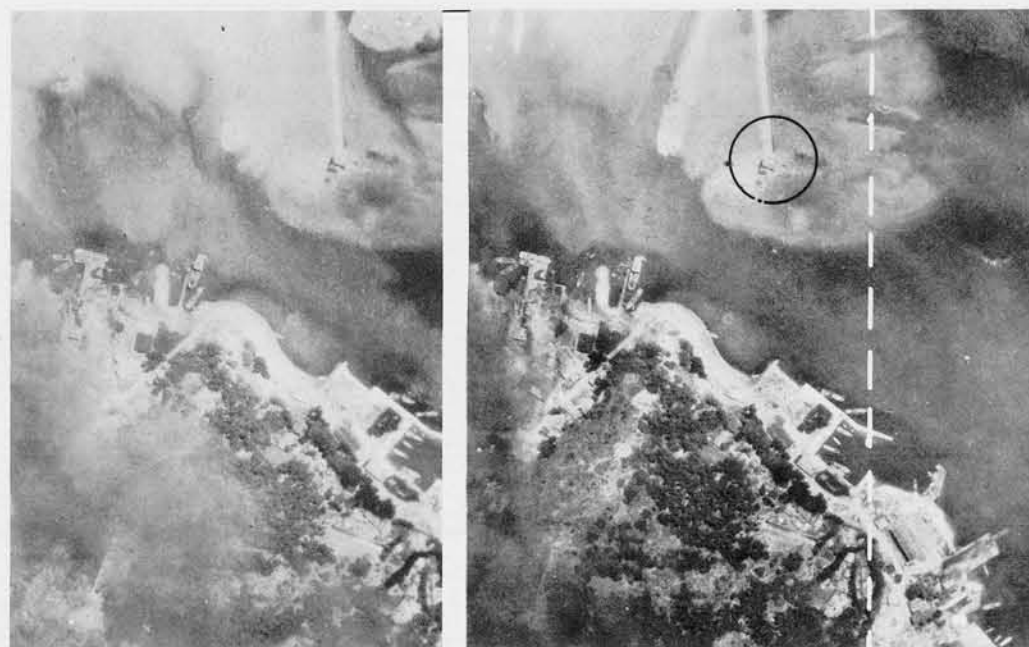
This installation at Chichi Jima is an unusual device which may be used for a Ship Navigational Aid.

It is difficult to delineate its exact construction from these photos, but certain forms seem evident: a long horizontal platform with vertical members (which are assumed to be dipoles) arranged as a fence on a catwalk, but some extending an equal distance below.

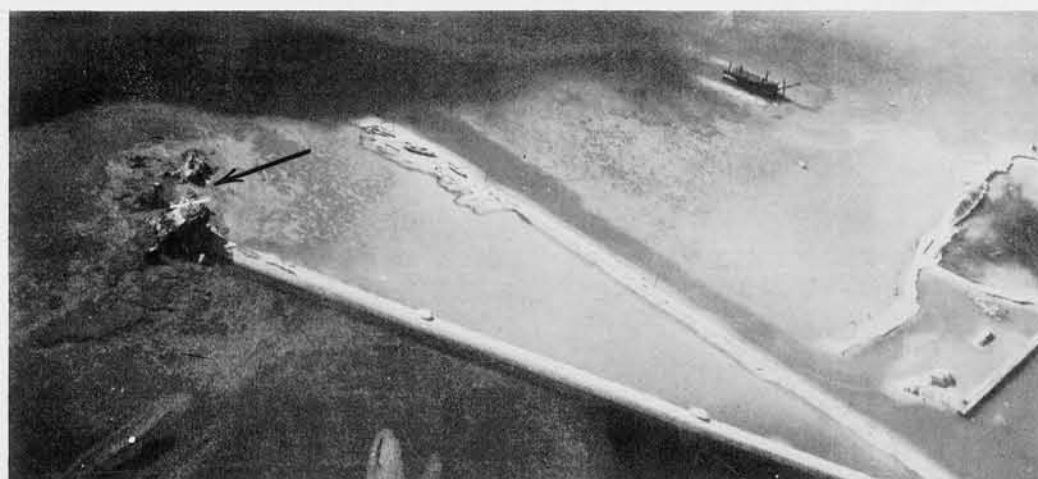
The whole 35 foot horizontal member appears to be capable of rotating on its base. The base, constructed with diagonal cross bracing, is about 15 feet high by 18 feet square in plan view.

The installation is located on the end of a breakwater, so as to command the entrance to the harbor.

If a Navigational Aid, this installation is undoubtedly for guiding surface vessels and probably operates at high frequencies (30 to 80 Mcs.).



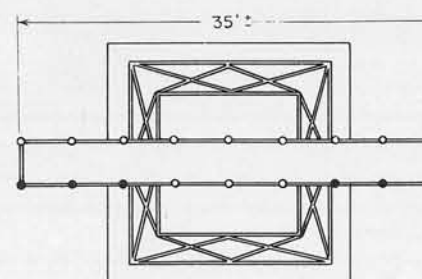
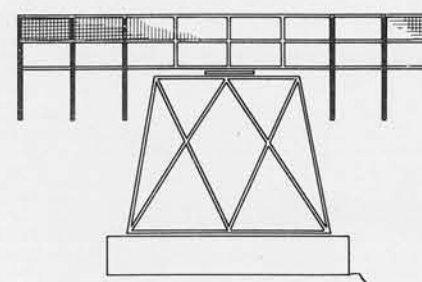
CHICHI JIMA, BONIN IS.



CHICHI JIMA



CHICHI JIMA



CHICHI JIMA

NAVIGATIONAL AIDS

SUMMARY (GERMAN)

The Germans have developed several types of Navigational Aids, operating at high frequencies, for homing aircraft and for directing aircraft to bombing objectives. Below is a table listing the most important standardized types.

In addition to those listed here are Lorenze Stations for homing aircraft, Benito D.F. stations for fighter control, broadcast and radio range stations, portable transmitters dropped near target, ship and submarine navigational beams and others.

FIVE IMPORTANT GERMAN AIR NAVIGATIONAL AIDS

NAME	SIZE OF AERIAL	TOP OF AERIAL ABOVE GROUND	FREQUENCY IN MEGACYCLES PER SECOND	RANGE IN NAUTICAL MILES	USE
KNICKEBEIN	147' WIDE DIAMETER OF TRACK = 98' 20° BEND	50'	30 TO 33.4	215	BLIND BOMBING & NAVIGATION (AZIMUTHAL NAV. BEAM)
RUFFIAN	70' WIDE	30'	66.5 TO 75	215	BLIND BOMBING (AUTOMATIC BOMB RELEASE OVER TARGET - NOW OBSOLETE)
BENITO	50' - 70' WIDE	30'	38.4 TO 45	85-175	BLIND BOMBING (AZIMUTHAL AND RANGING NAV. BEAM FOR BOMBERS & FIGHTERS)
WIND JAMMER	LOWER - 112' WIDE UPPER - 45' WIDE DIAMETER OF TRACK - 56'	82'	38.4 TO 42.3	85	G.C.I. CONTROL OF FIGHTER A/C
ELEKTRA	3 - 300' MASTS 2 MILES APART	300'	0.29 - 0.48	1300	LONG RANGE NAV. BEAM (A/C D.F.'s ON BEAM)

There are no photos shown here of the "Elektra". In lieu of pictures, the following description is given:

The complete installation consists of 3 masts about 300 feet high, laid out in a straight line at regular intervals of 1½ to 2 miles.

The three parts are separate but complimentary. Each mast is accompanied by a small hut adjacent. All three masts and huts are connected by buried cables to the transmitter, which is at or near the central mast.

Elektra is a low frequency fixed installation operating from 0.29 to 0.48 Mcs., and has a range of 1300 nautical miles.

Operation: Aircraft D.F.'s on station to determine which of several equi-signal beams he is on. Beams remain fixed.

Beams remain fixed as to direction, and probably are seldom changed for any given section.

NAVIGATIONAL AIDS

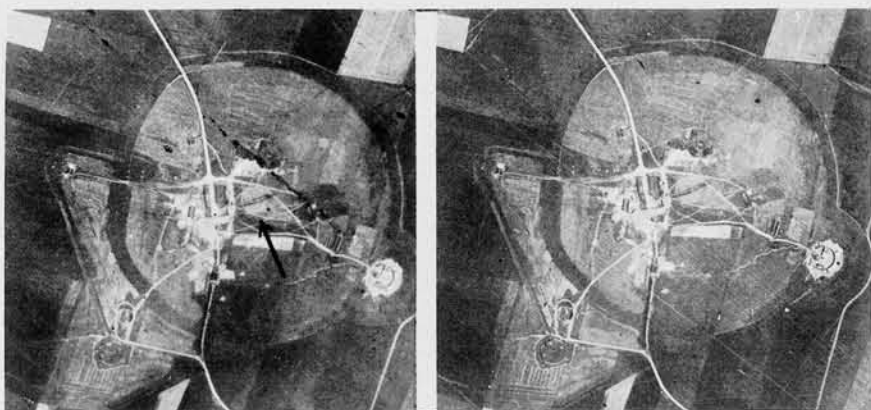
GERMAN



(R.F. - 1/10000)

KNICKEBEIN

The "Knickebein" is probably the best known of the German Navigational Aids. Its name is derived from the pronounced bend in the antennae framework. This bend can be detected by the shadow visible in the above stereogram. The track is 98 feet in diameter.



(R.F. - 1/9000)

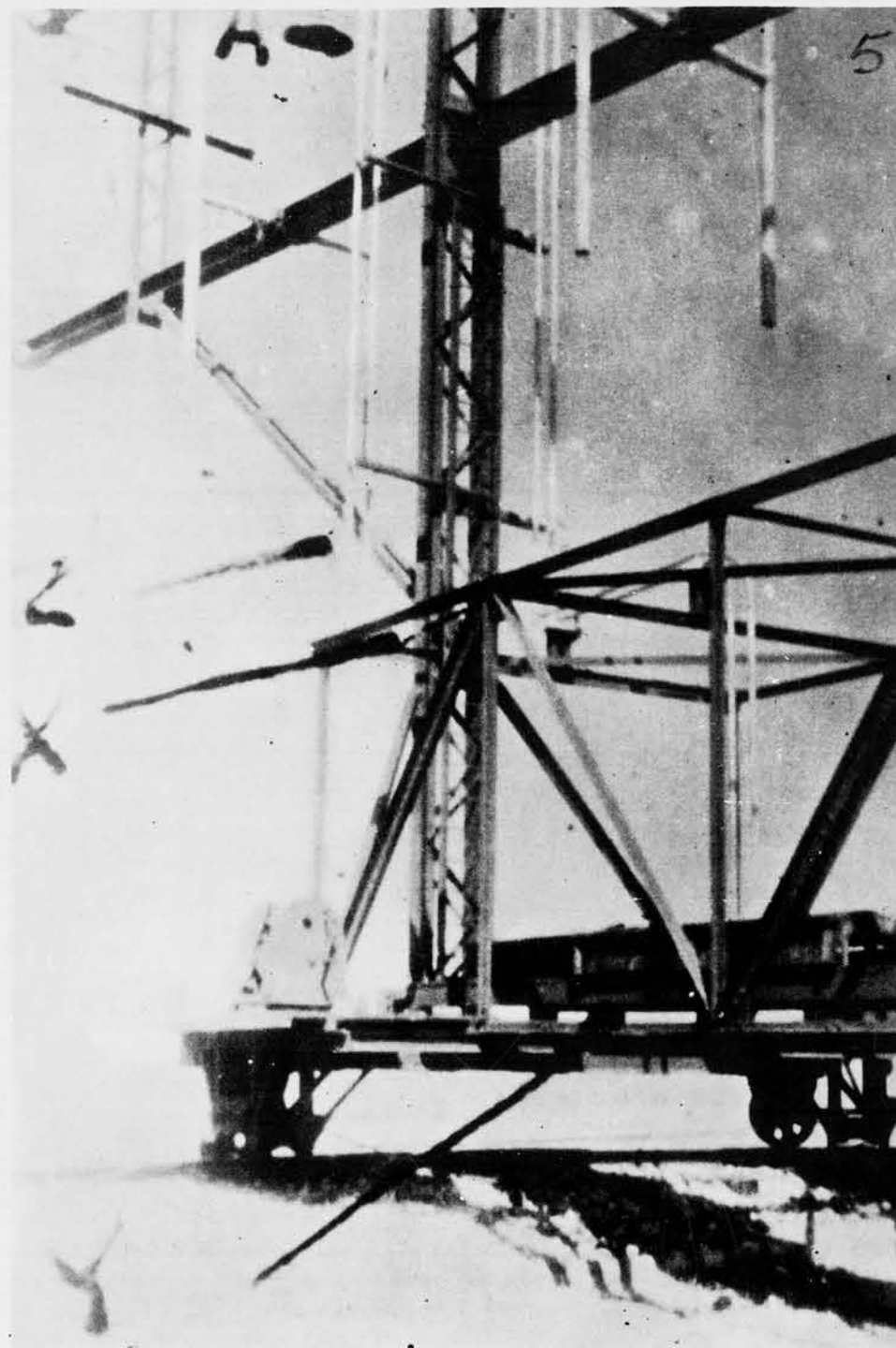
KNICKEBEIN

The "Knickebein" is an "Azimuthal Navigational Beam" with no provision for ranging. The pilot flies down the beam as in the case of an ordinary beacon or radio range. The frequency band is from 30 to 33.4 mcs.



KNICKEBEIN

The above oblique is a well known photo of an early design which is not typical of the standardized form now well known as the "Knickebein". This heavily constructed installation operates in much the same way as the "Knickebein", however, by transmitting a high frequency azimuthal beam.

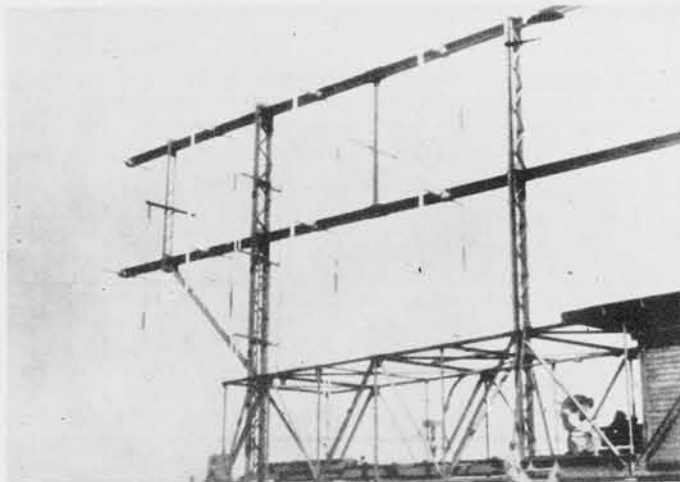


KNICKEBEIN

Closeup of antennae shows a series of dipoles, similar to those used with Radar equipment. Track and bogies for rotation of entire instrument are visible here. Cabin is built into framework of aerial and rotates with aerial.

NAVIGATIONAL AIDS

GERMAN (CONT.)



KNICKEBEIN

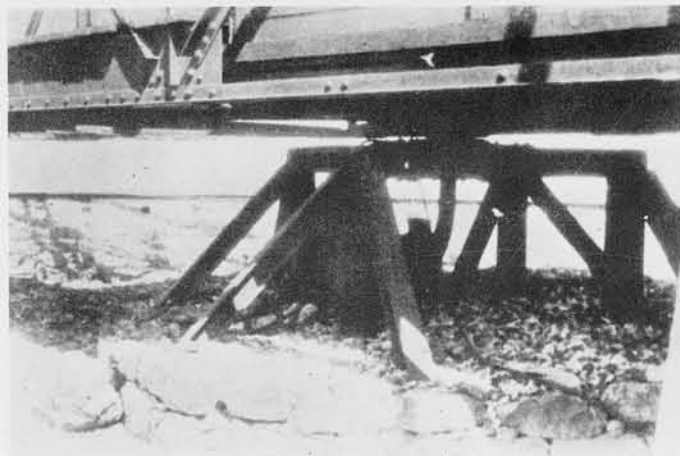
LEFT: View showing the 4 groups of dipoles and reflectors. Note corner of control shack in lower right.

The only other installation with which the Knickebein might be confused is the "Windjammer".

The Windjammer has no bend in its aerial as has the Knickebein.

The Knickebein has a wider and lower aerial than the Windjammer, and the diameter of the track is greater in the case of the Knickebein.

RIGHT: View taken across top of control shack showing center point of bend. There are two sets of four dipoles with reflectors on each side of the bend. The included angle of the bend is 160° .



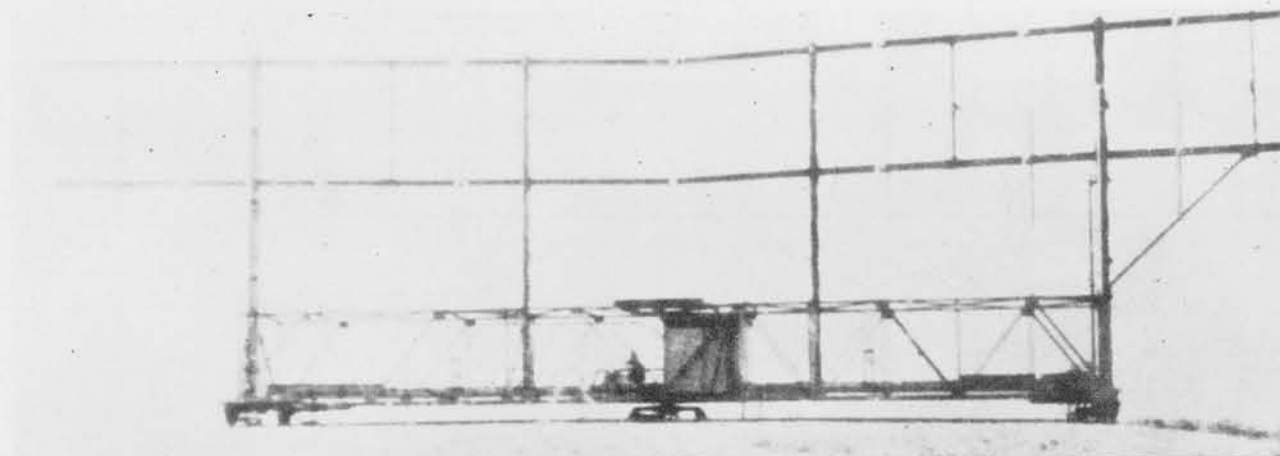
KNICKEBEIN

LEFT: Detail of central pivot of turntable. Weight is carried by bogies at ends, which travel on the circular track.

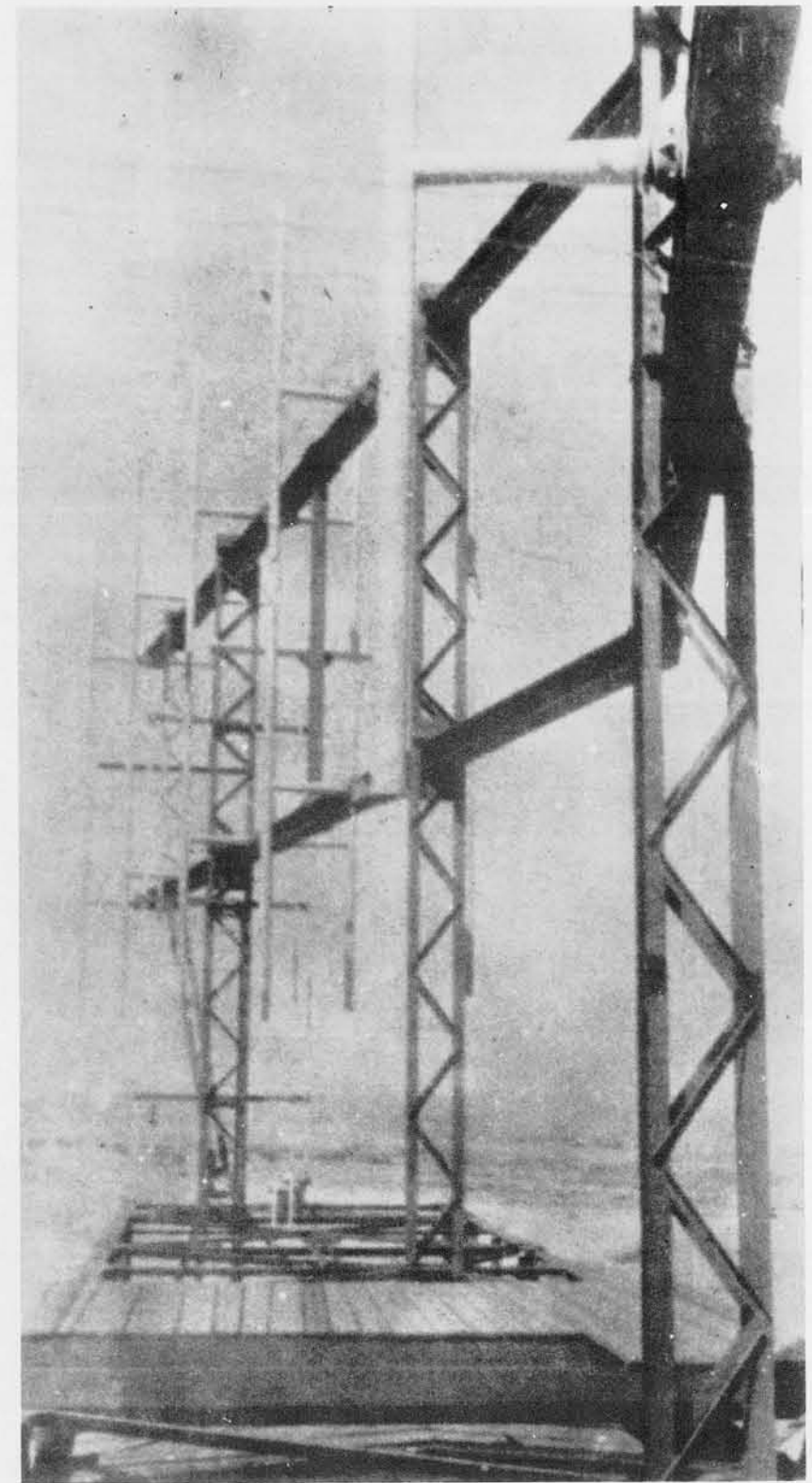
The small cabin is above this point (the Windjammer's cabin extends the full diameter of the track).

BELOW: Comprehensive view of front of "Knickebein". Aerial is 147 feet wide, track is 98 feet diameter, and the top of the aerial is 50 feet above ground.

Special equipment is necessary in the aircraft. Signal is a dot dash tone and shows on a meter indication.



KNICKEBEIN



KNICKEBEIN

CONFIDENTIAL

NAVIGATIONAL AIDS

GERMAN (CONT.)



(NO PARALLAX)

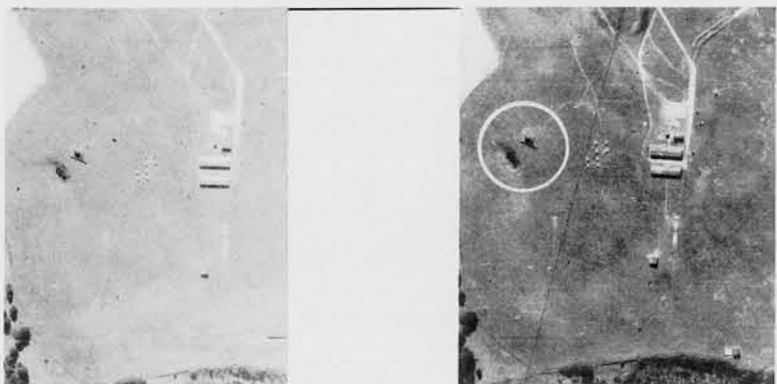
RUFFIAN

(R.F. - 1/7500 \pm)

The "Ruffian" is a blind bombing navigational aid which is now obsolete. It employed three sharply defined beams, one over target and two at right angles to target beam. These beams created an automatic bomb release over a specified target (London). Target beam and cross beams were received in aircraft at slightly different frequencies by two different receivers.

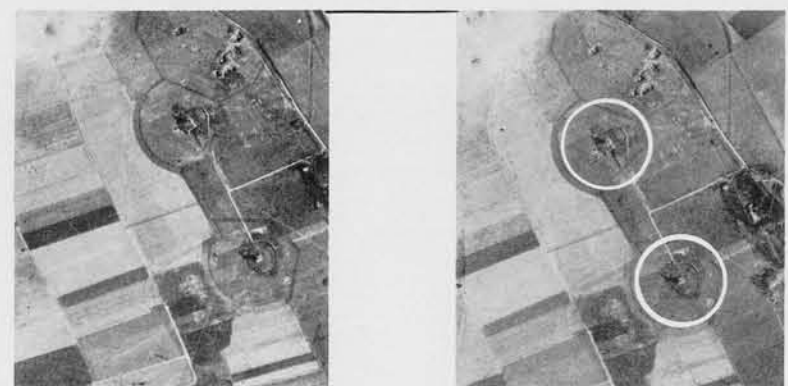
Frequencies were between 66.5 to 75 mcs.

Antenna consisted of a 70 foot cross arm, 30 feet above the ground, with vertical aerials.



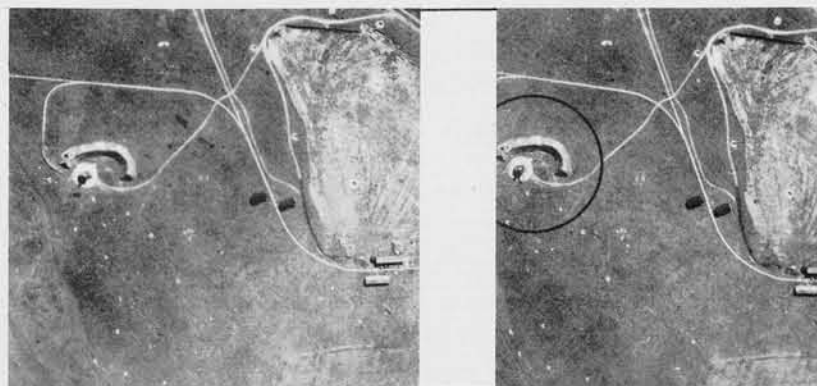
BENITO

(R.F. - 1/7500 \pm)



BENITO

(R.F. - 1/10000 \pm)



BENITO

(R.F. - 1/7500 \pm)

This installation appears to be a navigational aid and resembles a Benito type. Identification is not positive however. The stereogram is included to show the variety of forms such equipment may assume.

LEFT:

The Benito Navigational Aid for bombers is a transmitter of high frequency beams (38.4 to 48 mcs.) and is used for blind bombing giving both range and azimuth.

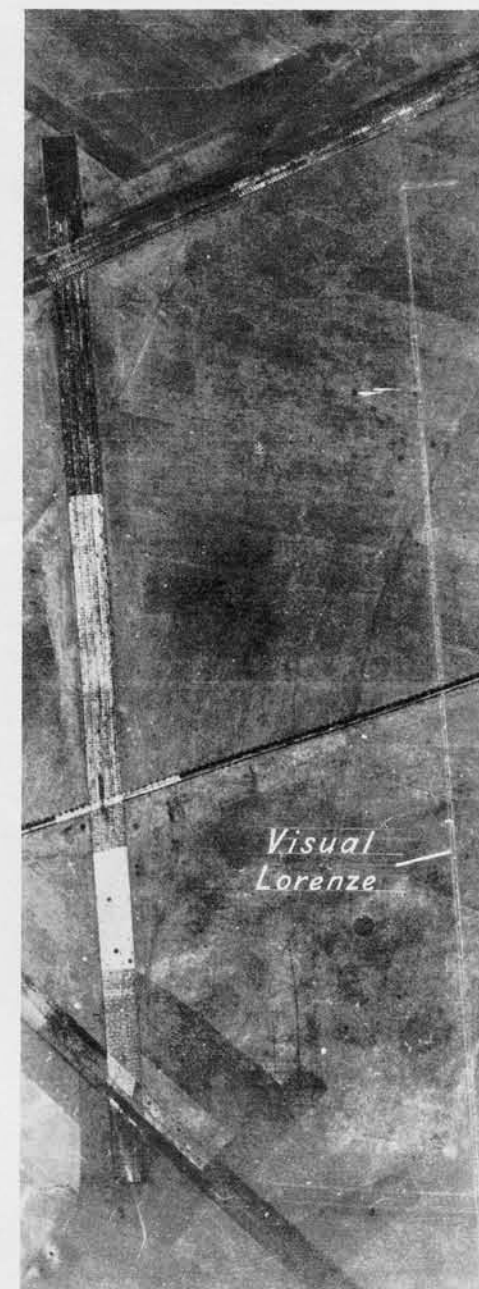
The antenna consists of a rotating cross arm of from 50 to 70 feet supported by "Y" type bracing and containing (in the case of the range antenna) a broadside array of 7 pairs of dipoles with reflectors. Two instruments are needed, one for range and one for azimuth.

The Benito can best be identified from aerial photographs by the shadow of the "Y" type cross arm supports which can be seen clearly in two stereograms shown here.



VISUAL LORENZE STATIONS

(R.F. - 1/10000 \pm)



VISUAL LORENZE STATIONS

ABOVE & LEFT: Visual Lorenze Stations are found on or near German airfields. Their purpose is to assist pilots in landing. The extensive white scar pattern created by buried cables is the best identification feature.

NAVIGATIONAL AIDS

GERMAN



WINDJAMMER MONITOR

On this page are views of the latest German Air Navigational Aid -- the "Windjammer".

The Windjammer is a Radio-Navigational Aid used in connection with German G. C. I. stations in increasing numbers. Its function in fighter control is supplementary to the Giant Wurzburg and it is less subject to jamming. The Windjammer gives slant range and bearing of aircraft.

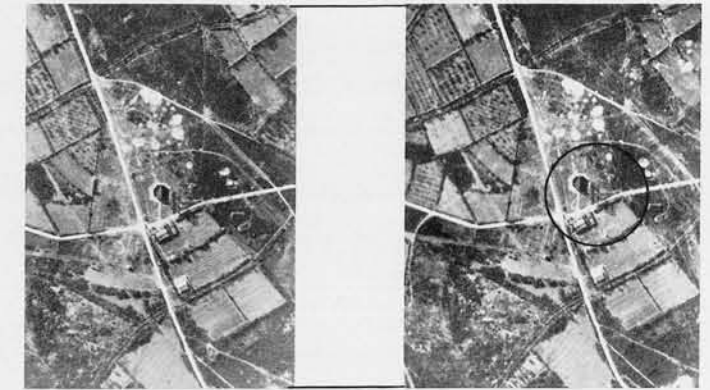
The track is 56 feet in diameter. The widest aerial (the lower aerial) is 112 feet wide. The upper aerial, shaped like a letter basket, is 45 feet wide. Top of aerial assembly is 82 feet above ground.

The elongated cabin, which rotates with the aerial, is divided into three main parts: the central section houses the control gear for the four electric motors, which rotate the structure; the right end (facing the aerial) contains the transmitting equipment; the left end contains work space.



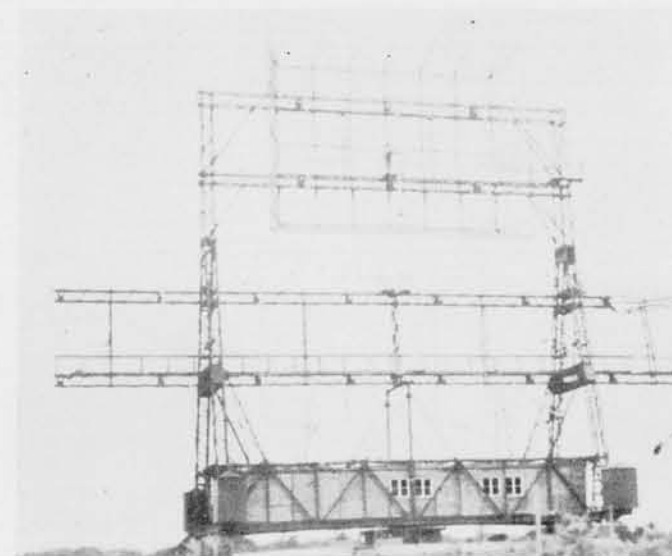
WINDJAMMER

In both of the above stereograms, it is clearly evident that this installation is a Windjammer and not a Knickebein. The lower aerial is 112' x 14' (ex-



WINDJAMMER (R.F. - 1/10000[±])

cluding projection of the dipoles); the upper aerial is 45' x 30', the top being 82 feet above ground.



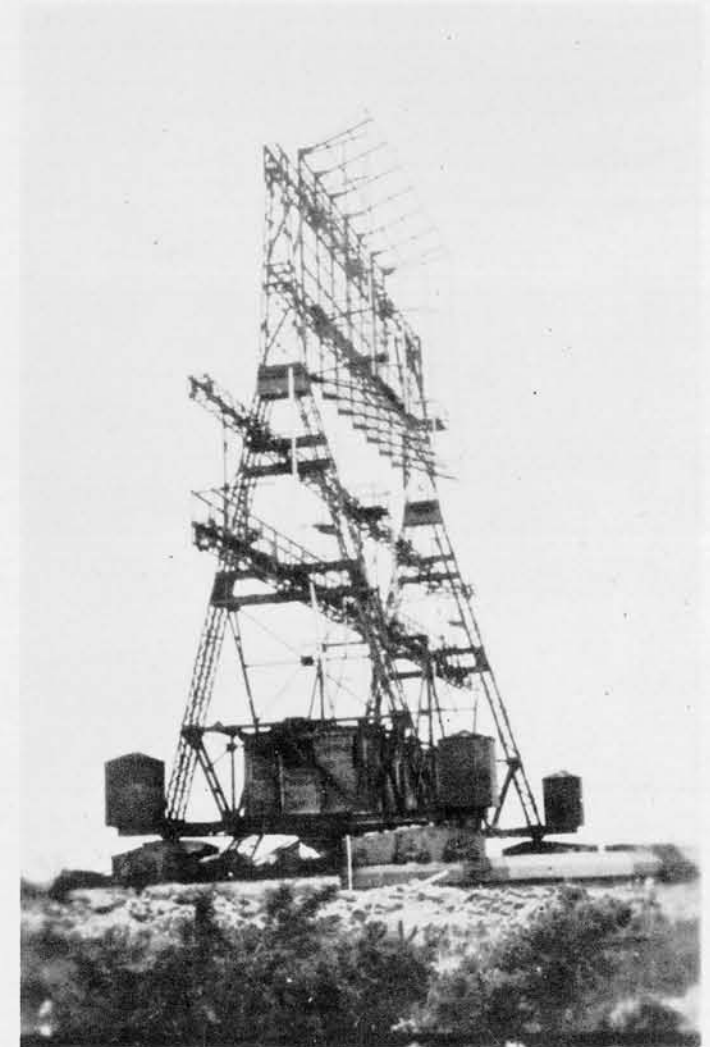
WINDJAMMER

The Windjammer (sometimes called "Benito for Fighters") operates at frequencies between 38.4 and 42.3 Mcs. Its range is about 85 nautical miles for aircraft at 10,000 feet altitude.

The Windjammer installation is accompanied by a Monitor Receiver which is 1/4 mile distant. The monitor consists of a 100 foot high lattice mast surmounted by an 8 foot high aerial (a hollow pipe).

This monitor may also be used for communications with the A/C in connection with G. C. I. control.

An underground cable can usually be seen running from the monitor mast to the Windjammer turntable.



WINDJAMMER

CONFIDENTIAL

SUPPLEMENTARY MATERIAL





SUPPLEMENTARY MATERIAL



SECTION-5

5.01 — 5.99

ELECTRONICS COMBINATIONS

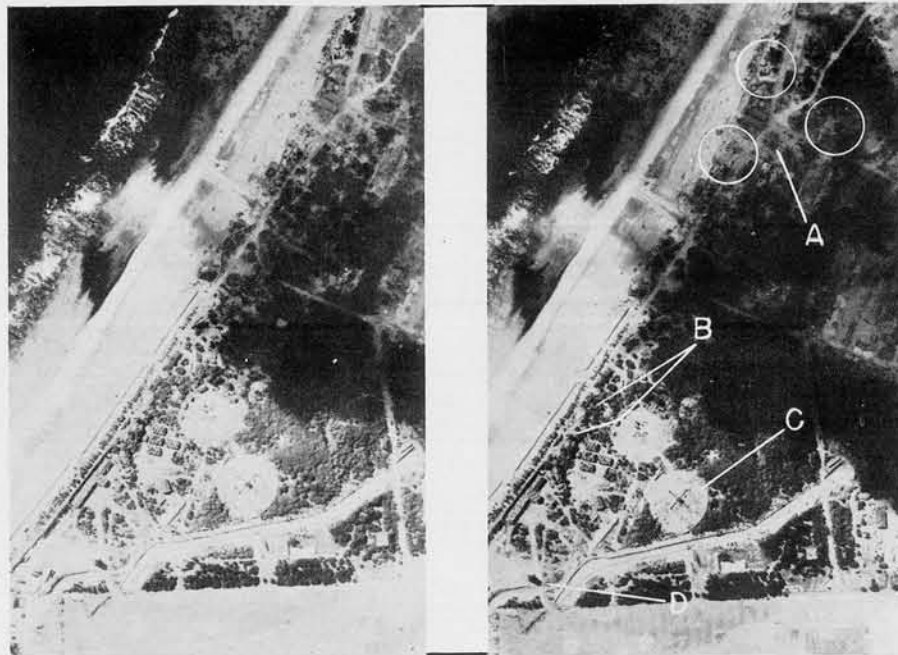
CONFIDENTIAL

ELECTRONICS COMBINATIONS

MARCUS ISLAND

"Electronics Combinations" section is composed of a selected group of Japanese controlled localities which afford particularly good opportunities for studying several types of electronics installations and their relationship to each other.

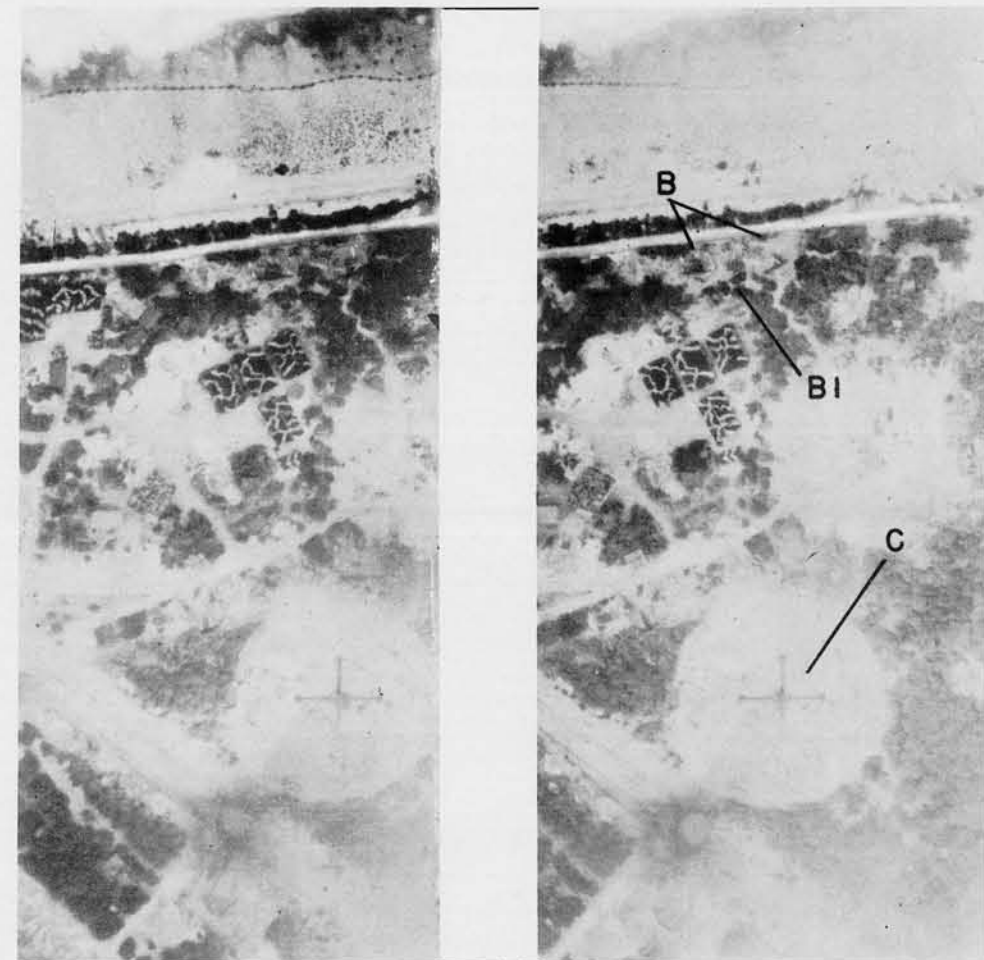
On Marcus Airfield, shown on this page, can be seen Communications, D.F., and Radar in combination.



MARCUS

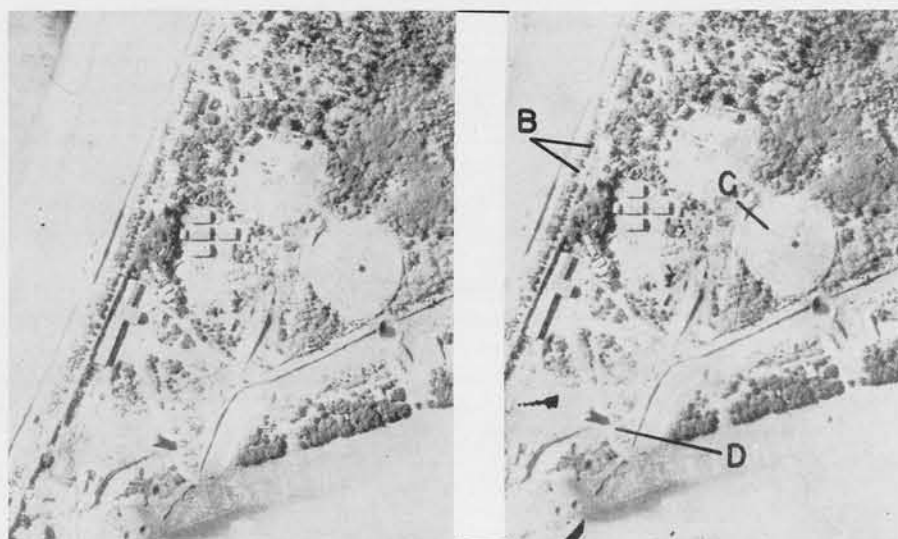
(R.F. - 1/9000)

"A" - MEDIUM FREQUENCY COMMUNICATIONS CENTER; "B" - TWO GUADALCANAL TYPE RADARS; "BI" - GENERATOR BUILDING FOR RADARS; "C" - MEDIUM FREQUENCY ADCOCK D.F.; "D" - HIGH FREQUENCY D.F. TOWER.



MARCUS

(R.F. - 1/3000)



MARCUS

(R.F. - 1/6700)



MARCUS

~~CONFIDENTIAL~~

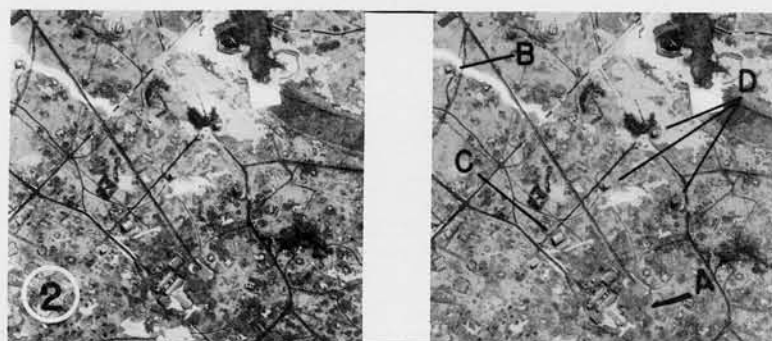
ELECTRONICS COMBINATIONS

MATSUWA ISLAND



(R.F. - 1/11000)

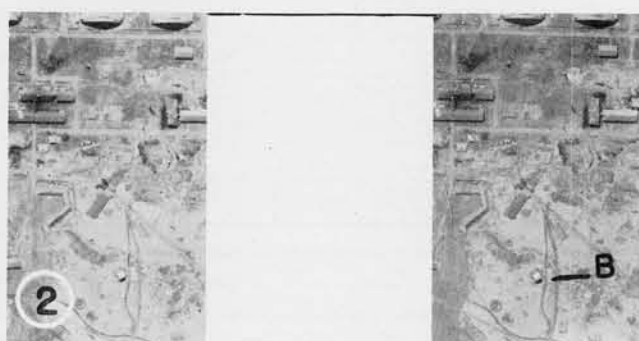
NORTHERN PORTION OF MATSUWA AIRFIELD



(R.F. - 1/11000)

D. F. CENTER

"A" - D. F. Center Building "B" - High Frequency D. F. Tower
 "C" - Probable Generator Building
 "D" - Three High Frequency D. F. Towers

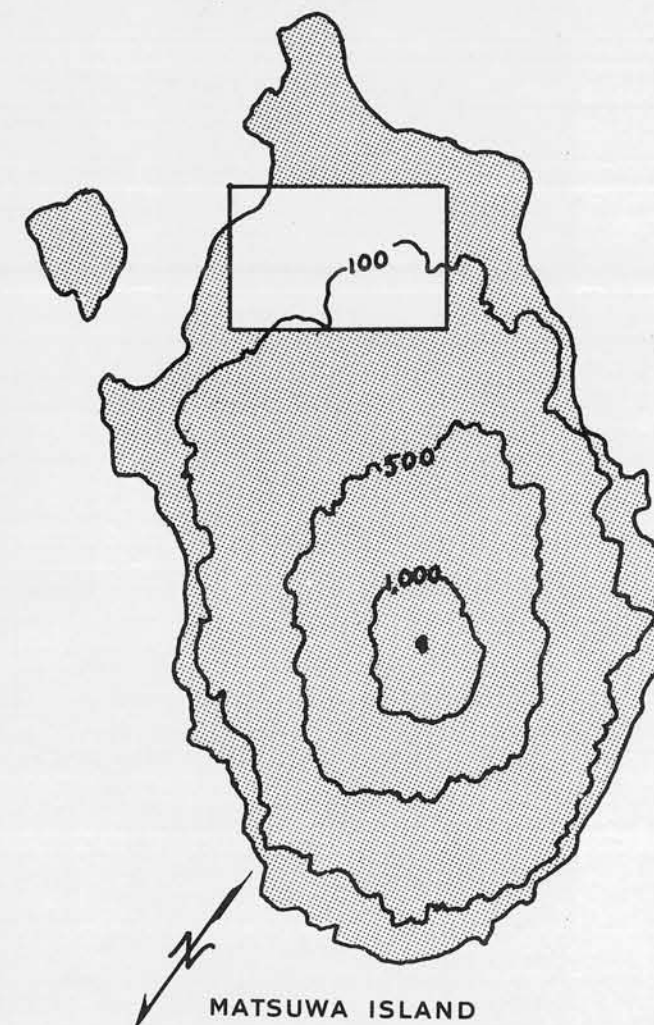


(R.F. - 1/7500)

D. F. TOWER

Detail at larger scale of D. F. Tower shown in stereogram to the left. This is probably a High Frequency Adcock.

The airfield at the southern tip of Matsuwa contains a fairly complete military electronics system. This set-up is unusual in one respect, however, for it does not include a large communications center with lattice masts, as do most large Japanese airfields. However, Medium and High Frequency stations, using stick masts, are present.



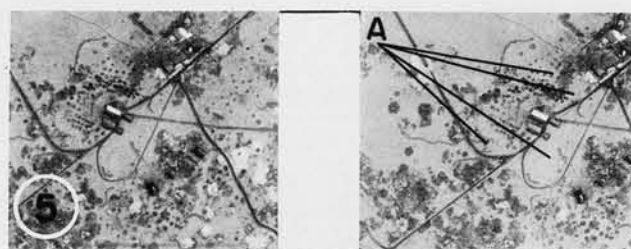
MATSUWA ISLAND

KEY TO INSTALLATIONS:

1. PROBABLE D. F.
2. LARGE D. F. CENTER
3. RADIO WEATHER STATION AND D. F. TOWER
4. RADAR STATION
5. COMMUNICATIONS STATION

ELECTRONICS COMBINATIONS

MATSUWA ISLAND (CONT.)



(R.F. - 1/11000)

COMMUNICATIONS

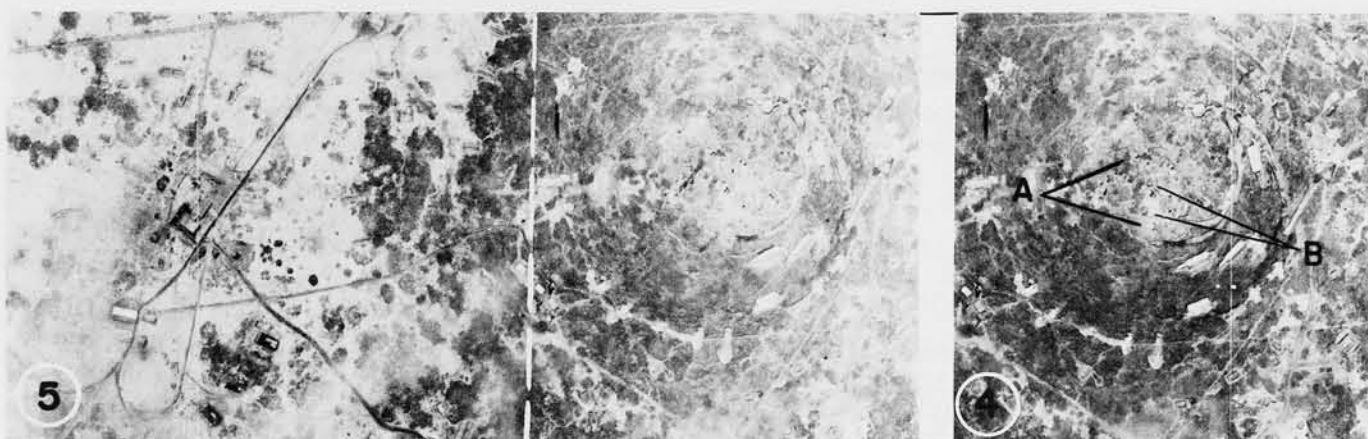
"5-A"-Four of several 75 foot high spliced wood stick masts of Medium Frequency Communications Station.

"4-A"-Two Attu type Radars. It will be noted by comparison with stereogram below, that one of these sets was moved to a new location after this coverage.



(R.F. - 1/11000)

RADAR STATION



(R.F. - 1/7500)

COMMUNICATIONS AND RADAR

Compare the above installations at each scale. It will be seen that the lower picture (1/7500), which was taken several weeks after the top group, reveals considerable change has taken place at the Radar station. Also note that the smaller scale reveals better detail on the Radio Communications Station than the larger.

"4-A" - Two Attu Type Radars (siting of one is changed)

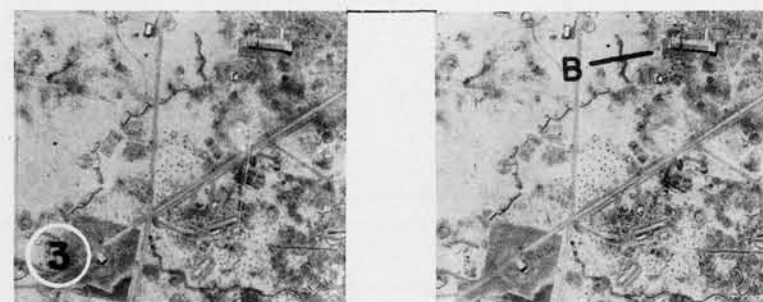
"4-B" - Two Mobile Mattress Radars



(R.F. - 1/7500)

D. F. TOWER

This tower, situated at the west end of the runway, probably encloses High Frequency D.F. equipment.



(R.F. - 1/7500)

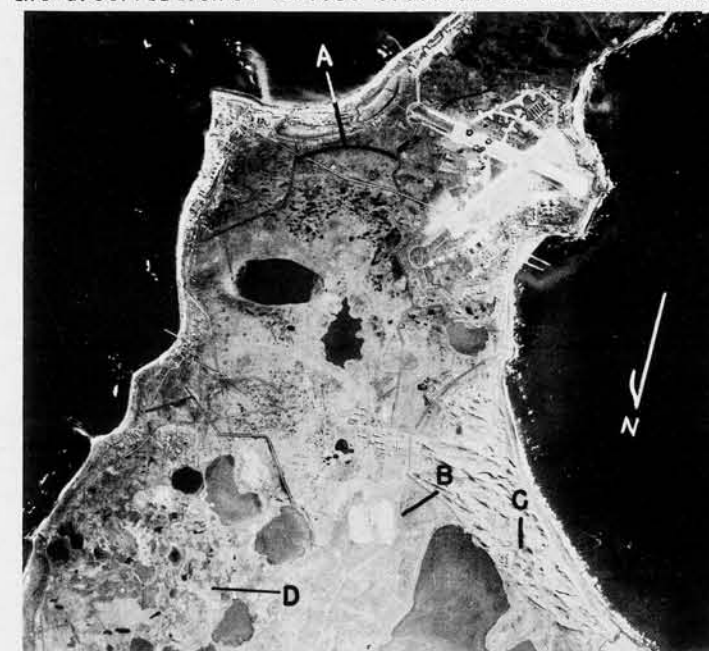
D. F. AND WEATHER STATION

This D.F. tower may enclose a Medium Frequency loop type, similar to Naval D.F.

At the Radio Weather Station (B), the small instrument houses and stick masts for radio are clearly visible.

KURABU CAPE, PARAMUSHIRO

Another airfield, also in the Kuriles, for study of the distribution of various electronics installations.



(R.F. - 1/38000)

KURABU CAPE

"A" - D. F. CENTER

"B" - RADIO RANGE STATION

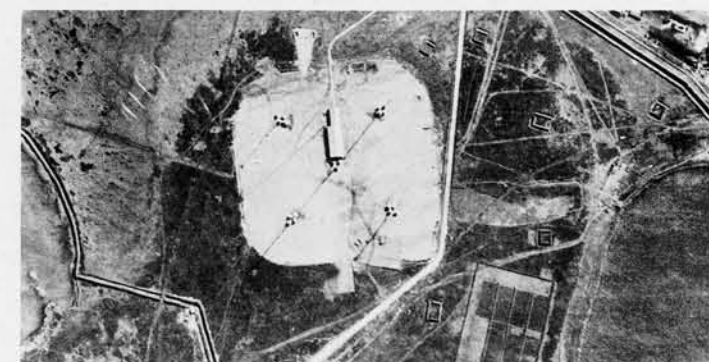
"C" - MEDIUM FREQUENCY COMMUNICATIONS CENTER

"D" - TWO GUADALCANAL TYPE RADARS



(R.F. - 1/10000)

D. F. CENTER



(R.F. - 1/10000)

RADIO RANGE STATION

CONFIDENTIAL

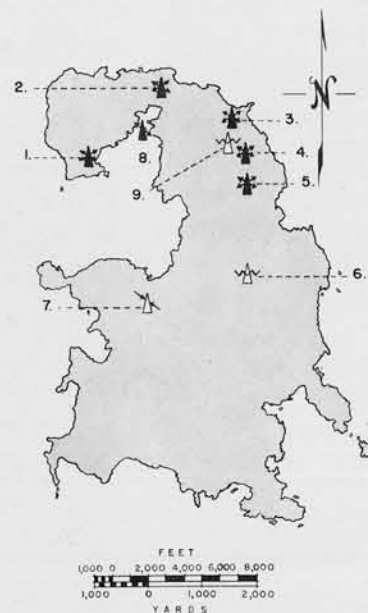
ELECTRONICS COMBINATIONS

CHICHI JIMA

Chichi Jima, in the Bonins, serves as a good illustration of a small area of Japanese land, well endowed with electronics installations.

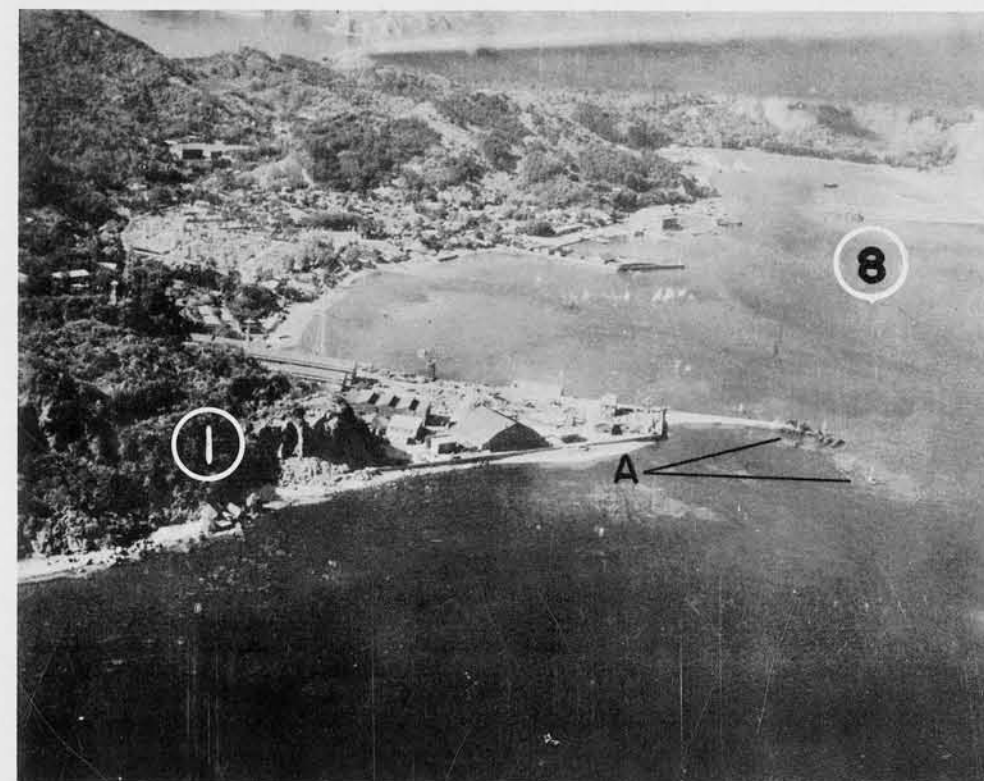
Especially worthy of note is the elaborate development of radio communications, there being five powerful long range stations within an area of two miles square.

In the area covered by these photos, the following Electronics installations have been found: five powerful Communications Stations, operating on medium and low frequencies; two search Radar Stations; one large Direction Finding Center; and one probable Navigational Aid for guiding ships into the harbor.



CHICHI JIMA, BONIN IS.

Numbers on photos are keyed to sketch map at right.



CHICHI JIMA

Oblique view of harbor showing low frequency station at seaplane base and probable ship navigational aid in background. "A" represents light beacons.

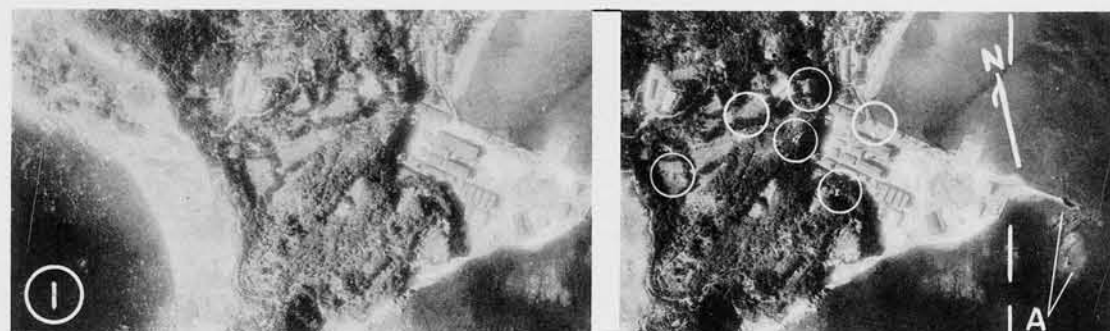


COMMUNICATIONS

"A" - See page 1.27



COMMUNICATIONS



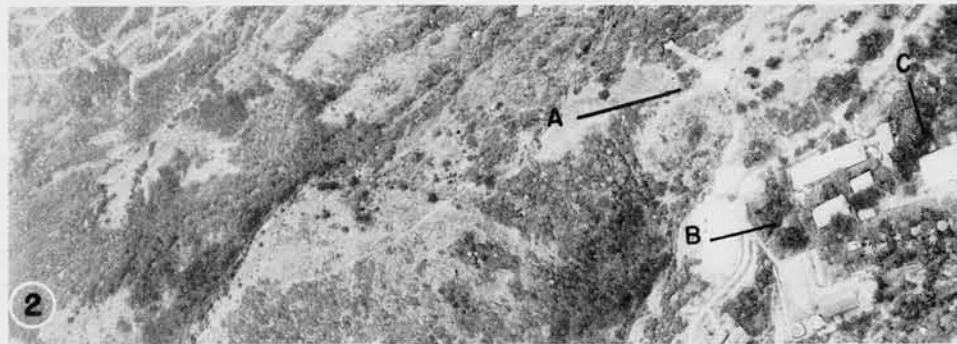
COMMUNICATIONS

(R.F. - 1/11200)

Six mast low frequency communications station at seaplane base. There may be two low frequency transmitters present. "A" - indicates light beacons.

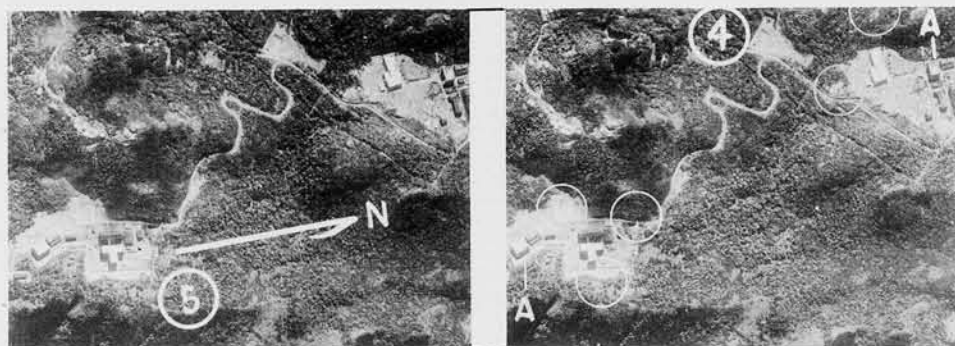
ELECTRONICS COMBINATIONS

CHICHI JIMA (CONT.)



COMMUNICATIONS

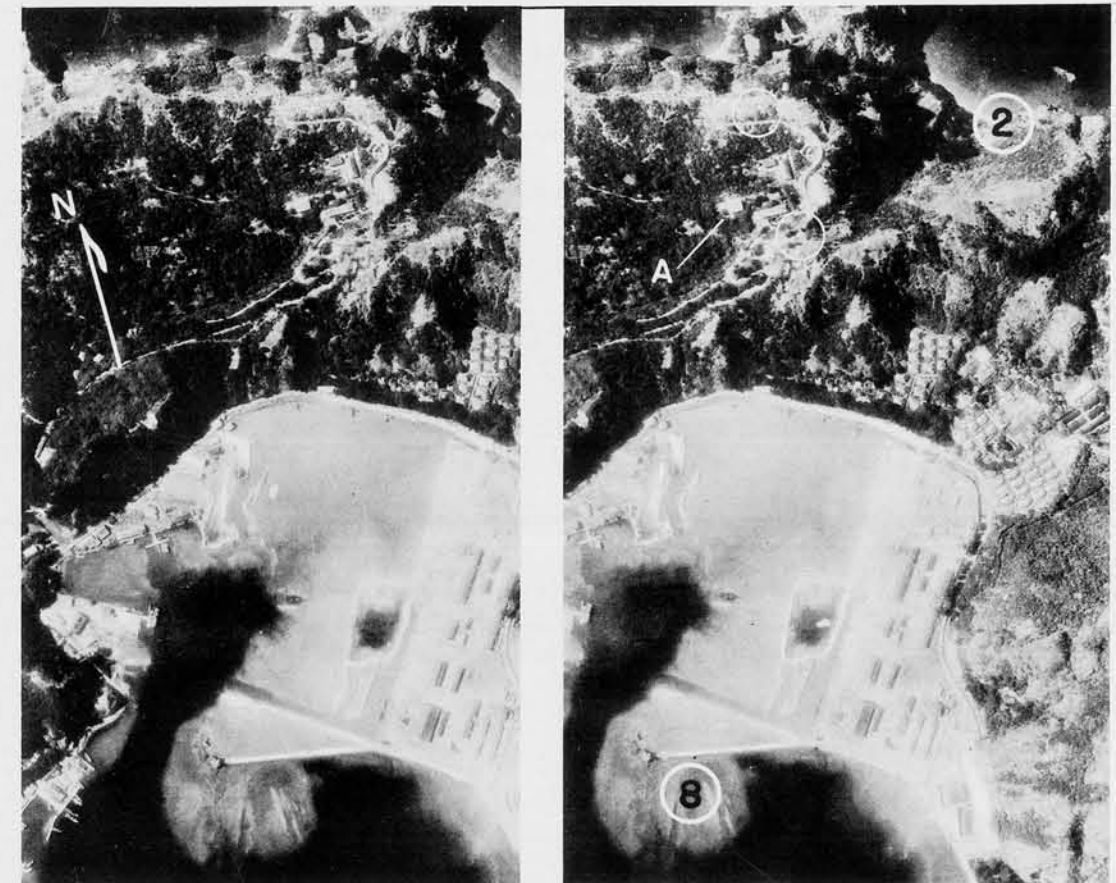
"A" - Low Frequency Lattice mast
 "B" - Transmitter building.
 "C" - Concrete power plant.



COMMUNICATIONS

(R.F. - 1/11200)

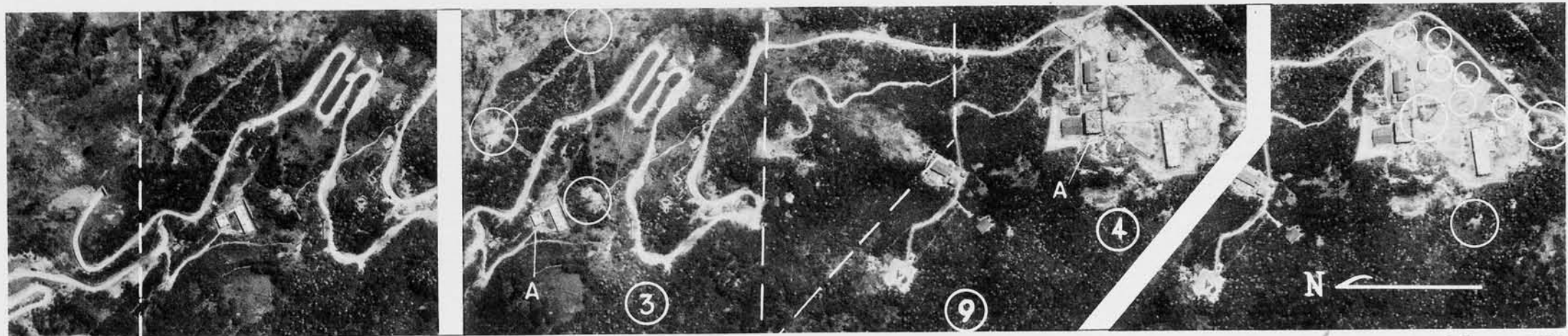
These two communications stations ("4" and "5") are probably medium frequency. The transmitter buildings (white concrete, surrounded by three lattice masts) are but 1800 feet apart. "A" - represents concrete power plant. Stick masts ("4"), indicate multi-frequency (directional?).



2- COMMUNICATIONS; 8- NAVIGATIONAL AID

(R.F. - 1/11200)

Stereogram showing probable ship navigational aid installed at inner end of harbor. Above the harbor is one of the five large communications stations. This is probably low frequency. "A" is concrete power plant. The transmitter building is that building closest to the power plant.



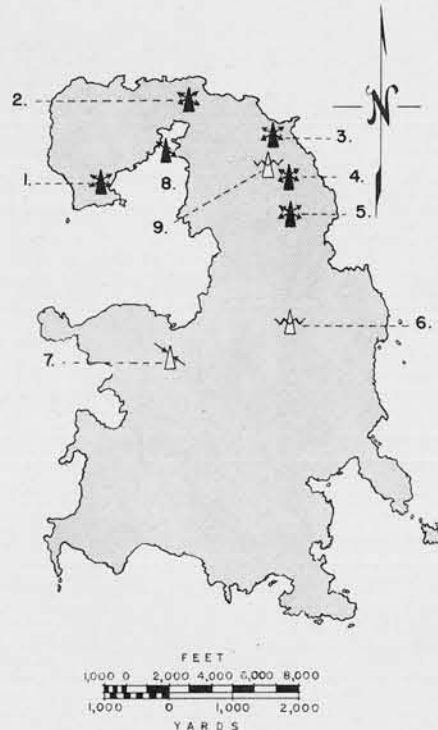
3 & 4 - COMMUNICATIONS & 9 - RADAR

(R.F. - 1/5500)

CONFIDENTIAL

ELECTRONICS COMBINATIONS

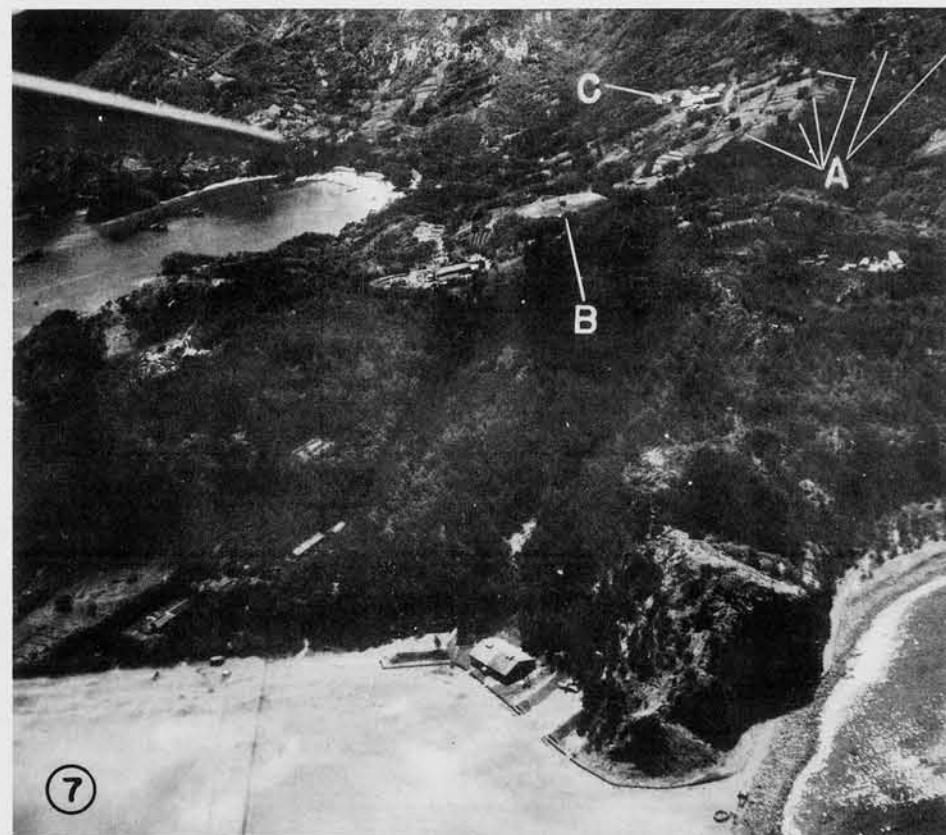
CHICHI JIMA (CONT.)



CHICHI JIMA

On this page are shown some of Chichi Jima's D.F. and Radar installations. The D.F. is adjacent to the airfield which is near the west coast of the island.

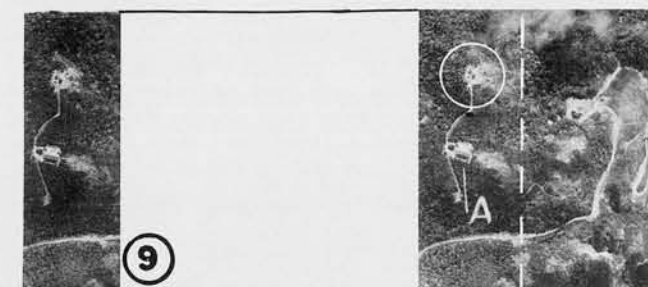
Both Radar sets are mounted on high peaks inland.



DIRECTION FINDING CENTER

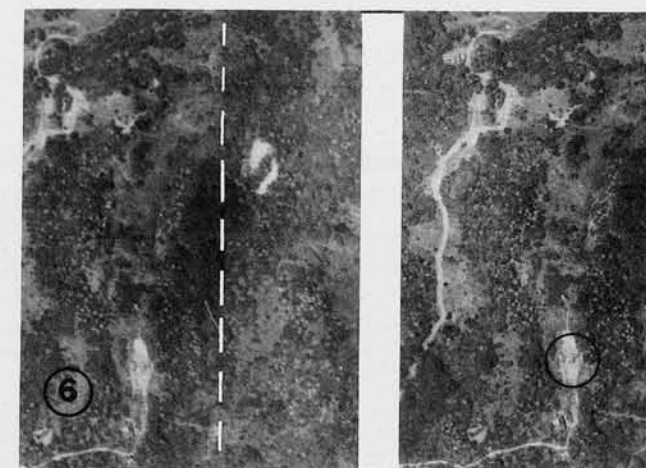
- "A" - Six High Frequency D.F. Towers.
- "B" - One Medium Frequency Adcock.
- "C" - D.F. Center and Reporting Station.

Airfield is located to the right (off the picture). This D.F. center has an unusually large number of High Frequency installations.



(R.F. - 1/11200)

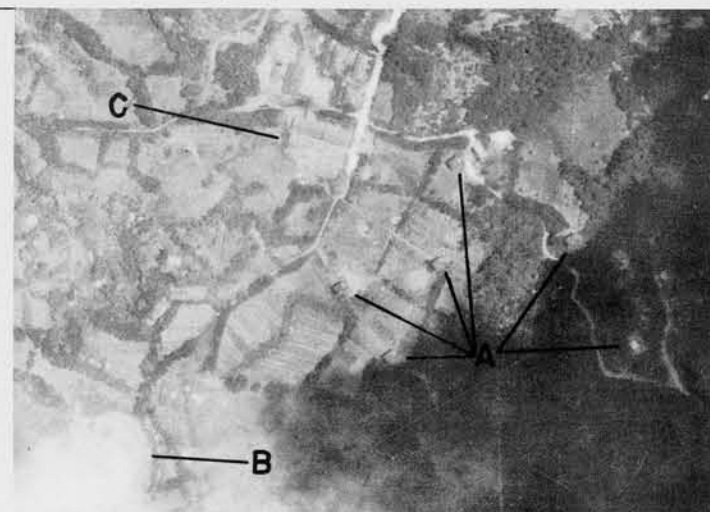
NORTH RADAR STATION



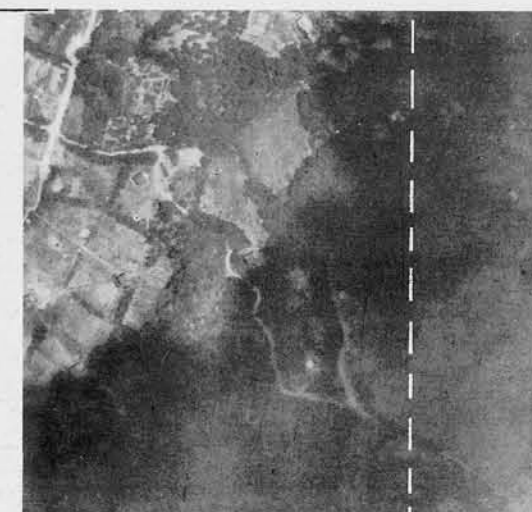
(R.F. - 1/5500)

SOUTH RADAR STATION

"A" - A somewhat standardized building group appears at both Chichi Jima Radar Stations. (Some of the buildings are off photo to lower left in stereogram of south Radar.) Barracks, observation, plotting are probably uses.

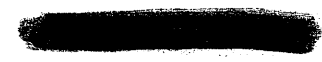


DIRECTION FINDING CENTER



(R.F. - 1/5500)

SUPPLEMENTARY MATERIAL





SECTION-6

6.01 — 6.99

RELATED INSTALLATIONS

~~CONFIDENTIAL~~

RELATED INSTALLATIONS

GENERATOR BUILDINGS

"Related Installations" section is composed mainly of reference material on electric power, including power buildings, transformers, transmission lines etc.

The smallest power building types, housing but one Diesel engine and generator, are called "Generator Buildings" (see below). They are used to supply power to some particular military installation. The buildings are usually of wood construction.

The "Military Power Plants" are usually constructed of heavy reinforced concrete and contain two or more Diesel engines and generators. They are nearly always accompanied by a "Water Cooling Tank Building" and an "Oil Storage Building".

These plants supply power to a number of military installations, or to a "Radio Communications Center".

When used with a Communications Center, the generator building itself becomes an integral part of the standard concrete building (which also houses the transmitter, offices, and batteries). The oil and water buildings, however, remain as separate structures.

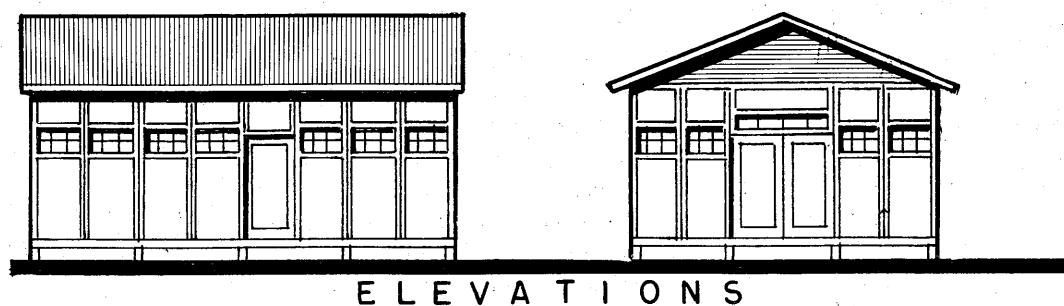
Several views of "Large Power Stations" show hydro-electric and steam power stations in Japan. Such plants supply power to large industrial areas and to cities. The Japanese have built a great number of hydro-electric plants, which are easily identified on aerial photographs.

In addition to the military power plants and generator buildings shown are several other less used designs as well as the rather common practice of burying the generating equipment or concealing it in a cave.

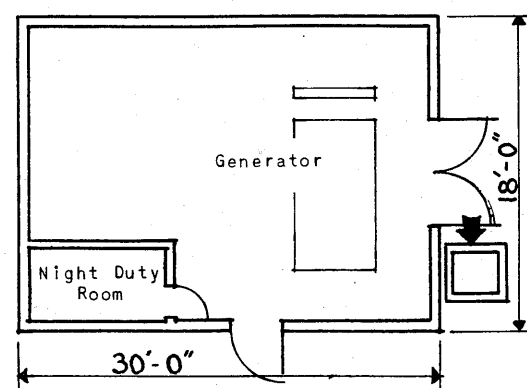
BELOW: Drawings (from captured sketches) of two standard building types which are reported to have been used at Nauru are shown here for reference. These buildings are designed for prefabrication. When built entirely by local contract, these structures may vary in appearance.

In addition to Radar and D.F. generator buildings, the Japanese also use similar prefabricated types for use with anti-aircraft batteries (ground plan 26' x 20') and for coastal defense batteries (ground plan 36' x 26').

It is thought that the more common design for a D.F. generator building entails the use of buttresses similar to those used on D.F. towers.

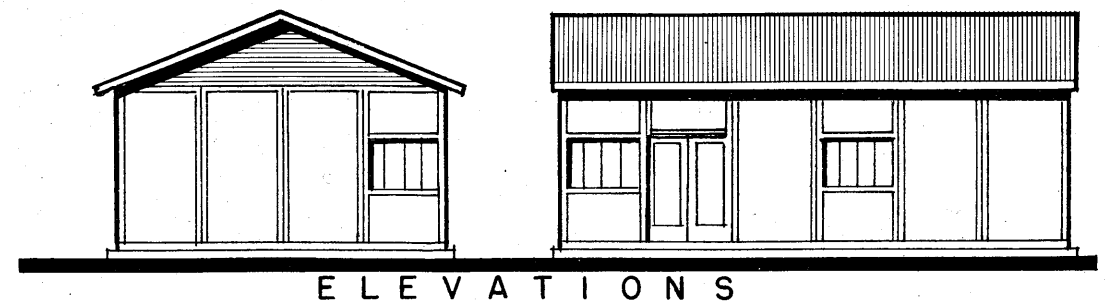


P L A N

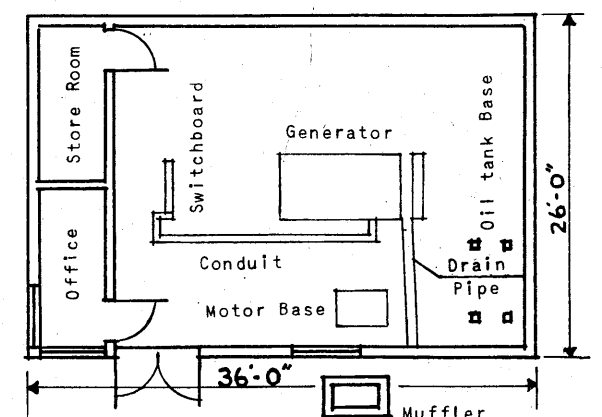


PREFABRICATED GENERATOR BUILDING FOR RADAR. This design was used at Nauru. Building is 18' x 30' in plan and is about 9 feet high from ground to eaves. Arrow points to muffler.

GENERATOR BLDG.—RADAR



P L A N

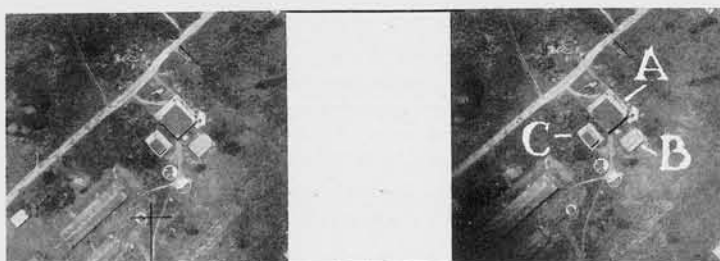


PREFABRICATED GENERATOR BUILDING FOR DIRECTION FINDER STATION. This type used at Nauru was 26' x 36' in plan and 10 feet high from ground to eaves. (This building may be higher and have buttresses).

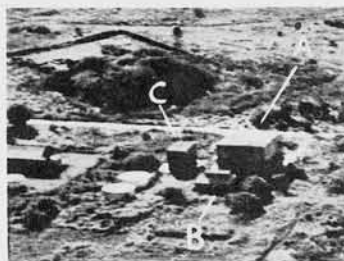
GENERATOR BLDG.—D.F.

RELATED INSTALLATIONS

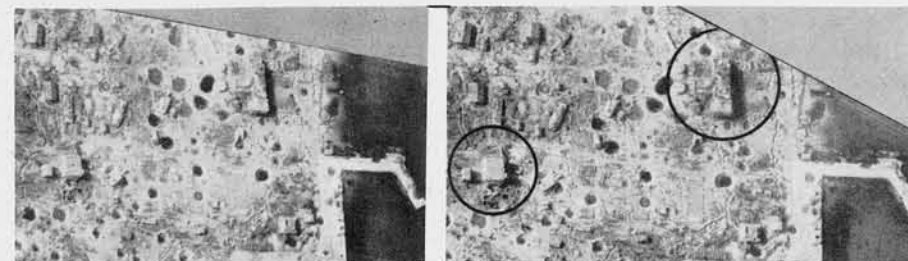
MILITARY POWER PLANTS



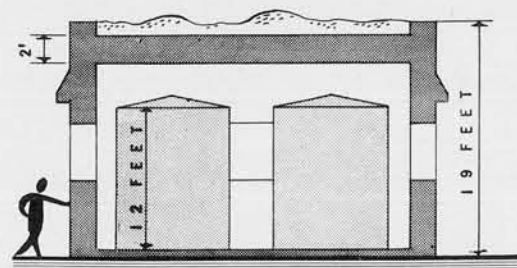
POWER PLANT GROUP - SAIPAN (R.F. - 1/4800)



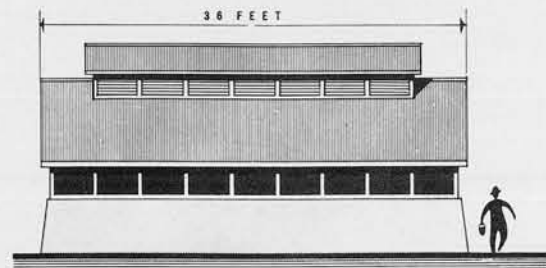
SAIPAN



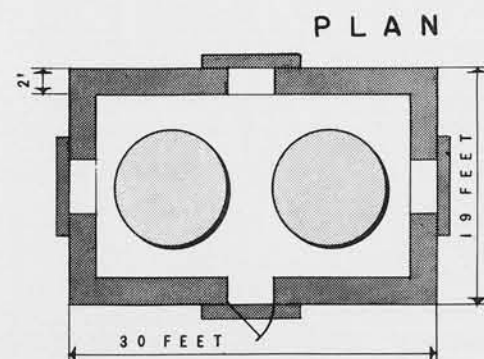
JALUIT (R.F. - 1/5000)



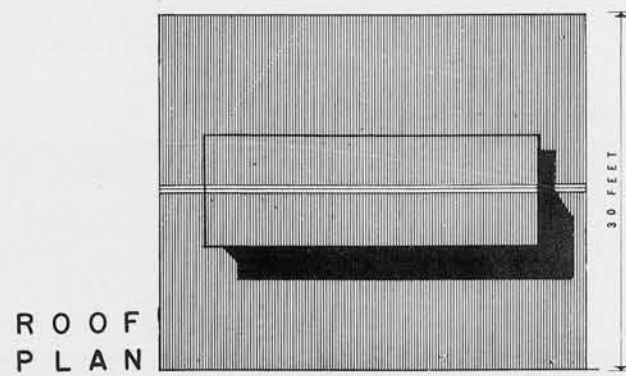
SECTION



ELEVATION

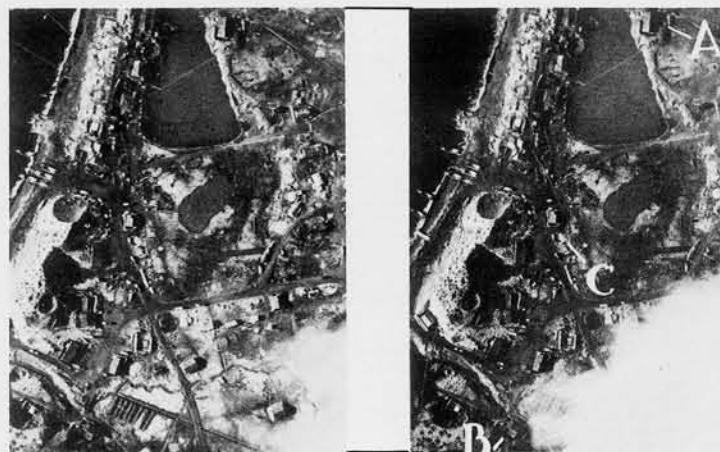


OIL STORAGE BLDG.



ROOF PLAN

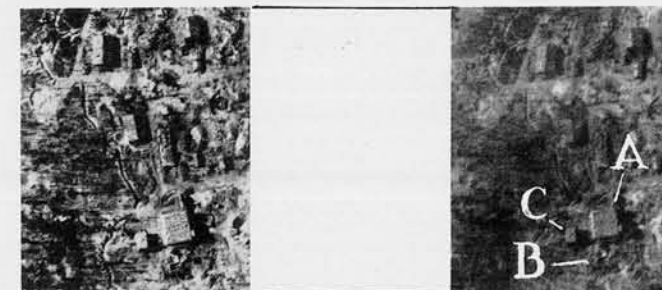
WATER COOLING BLDG.



KISKA (R.F. - 1/6200)



KISKA (R.F. - 1/3000)



JALUIT (R.F. - 1/4000)

Japanese power plant groups such as those shown above are fairly well standardized throughout the island areas. They consist of the following:

- "A" - CONCRETE GENERATOR BUILDING 48' x 55' x 22' HIGH
- "B" - WATER COOLING TANK BUILDING 18' x 28'
- "C" - CONCRETE OIL STORAGE BUILDING 19' x 30' x 19' HIGH

The Water Cooling Tank building is merely covering for the tanks. The structure is of wood with a monitor roof, the top of which is 15 feet above ground. The Oil Storage building is heavy concrete with a flat roof, sometimes covered with earth.

The top stereogram of Jaluit shows a Power Plant Group on the left, and a concrete Communications Center on the right, which contains its own power plant.

FAR LEFT: Two revetted wooden power plant buildings in the Aleutians.

- "A" - NORTHERN POWER PLANT 35' x 55'
- "B" - SOUTHERN POWER PLANT 35' x 35'
- "C" - RADIO STATION

Note oil storage near Northern power plant. This type of power plant is not as typical at the present time as the ones shown above. These are quite vulnerable to bombing attack.

LEFT: Northern power plant reconstructed and enlarged after original was damaged by U. S. bombing.

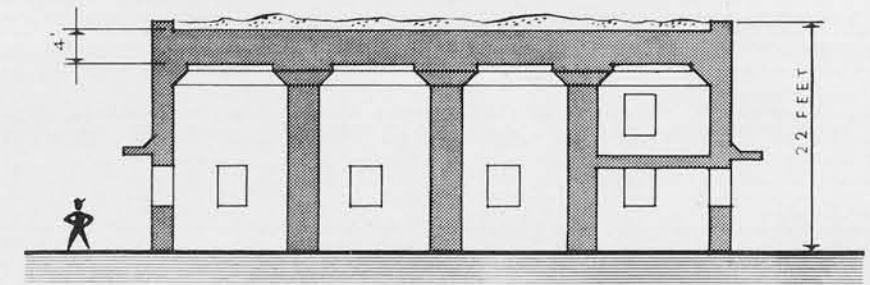
RELATED INSTALLATIONS

MILITARY POWER PLANTS (CONT.)



MALOELAP

- "A" - 48' x 55' CONCRETE POWER PLANT
- "B" - WATER COOLING TANK BUILDING
- "C" - CONCRETE OIL STORAGE BUILDING

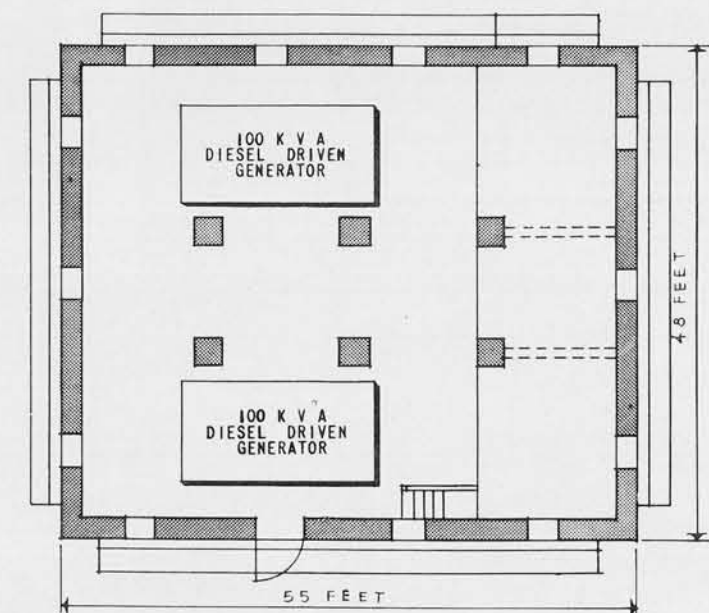


SECTION



DIESEL GENERATOR

This type of engine (also example below, left) stands about ten feet high when set on its mountings, and thus requires a high ceiling in buildings where installed.



CONCRETE POWER PLANT

Standard concrete Power Plant building. The dimensions are 48' x 55' x 22' high. These structures are very strongly built, having walls 2' thick and roof 4' thick, covered by earth which is filled to the level of the tops of the parapets. Vents are usually visible in roof. Six heavy (4' square) reinforced concrete columns are used to support the roof slab.

There are other types of concrete Military Power Plants in use by the Japanese. However, this design is shown because it has been seen most often up to the present date.

Two examples of large Diesel engines with generators of the type used in Military power plants are shown on this page.



DIESEL GENERATOR



KWAJALEIN

CONFIDENTIAL

RELATED INSTALLATIONS

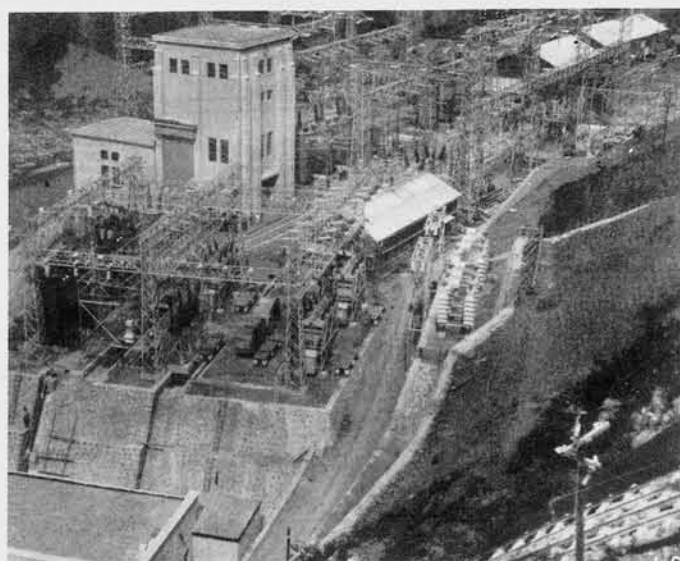
LARGE POWER STATIONS

On this page are shown pre-war photos of a few Japanese large scale power stations. These electrification projects are distributed over the Japanese homeland for industry and city power.

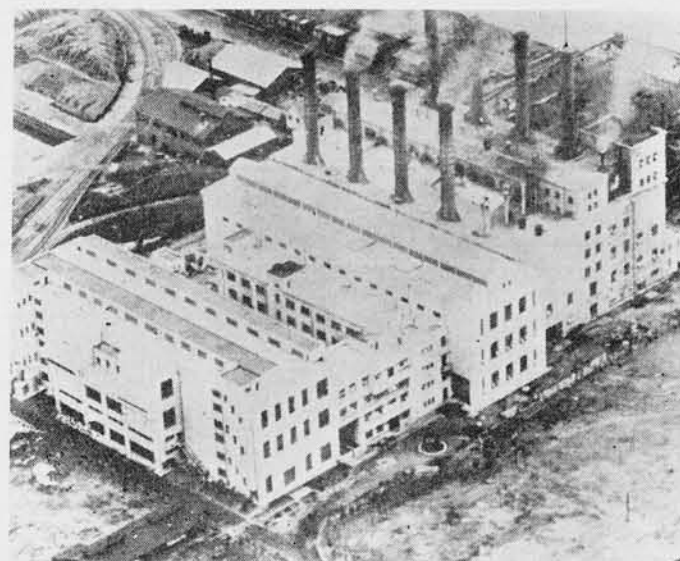
Most Japanese power is hydro-electric, which can be easily identified on aerial photos by the

penstocks, transformers, and by the large power line towers in the vicinity.

In areas supplied by these stations, individual military power plants, such as are shown in preceeding pages, will not be necessary, and spotting of electronics devices will be more difficult.



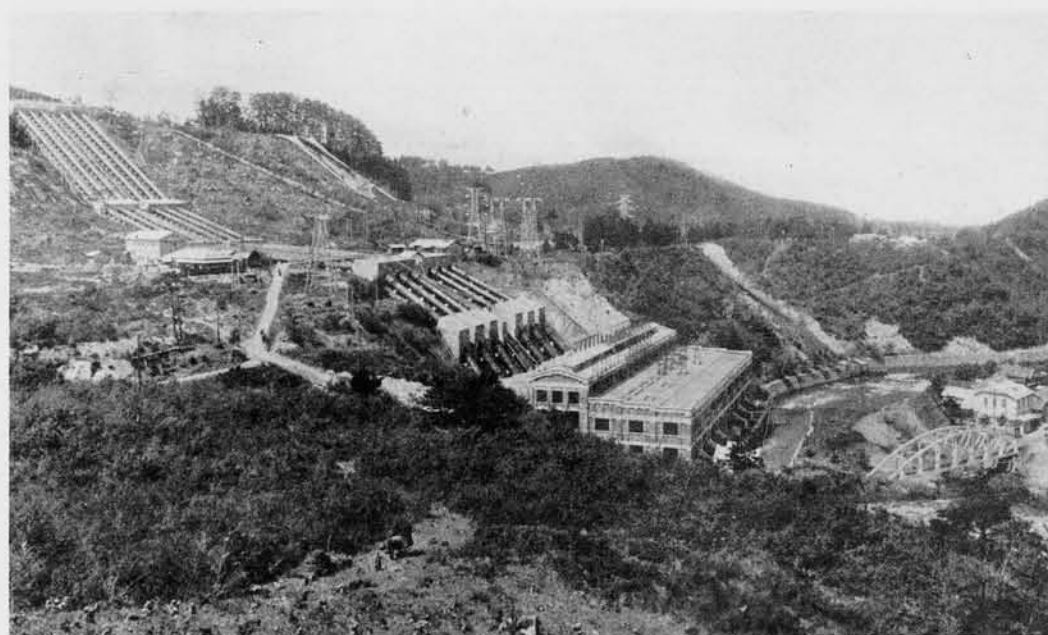
TRANSFORMER ARRAY



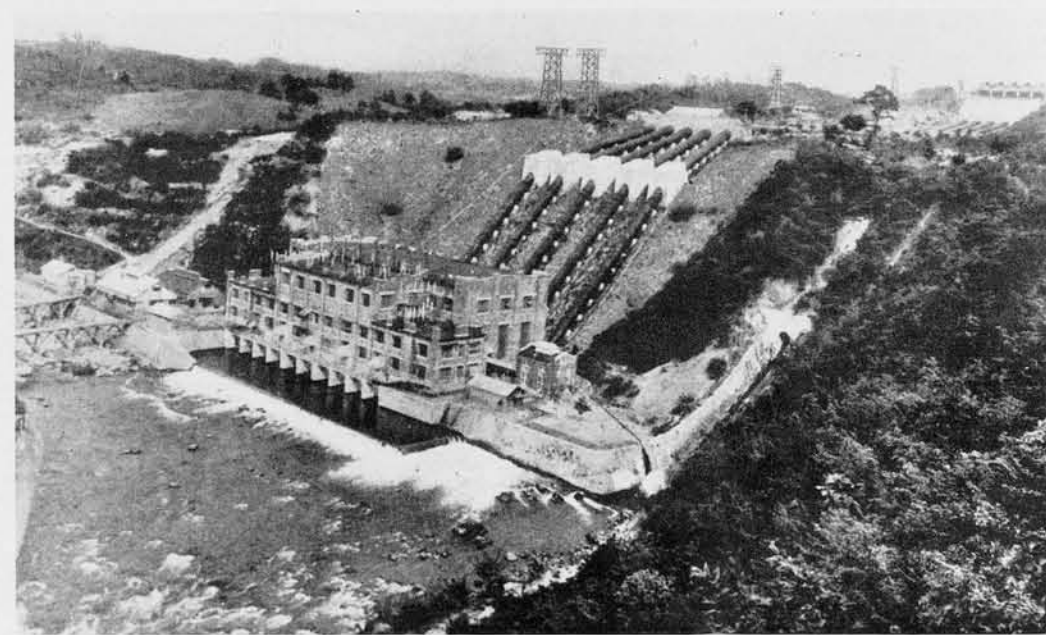
KAWASAKI R.R. POWER STATION



YANAGAWA POWER STATION



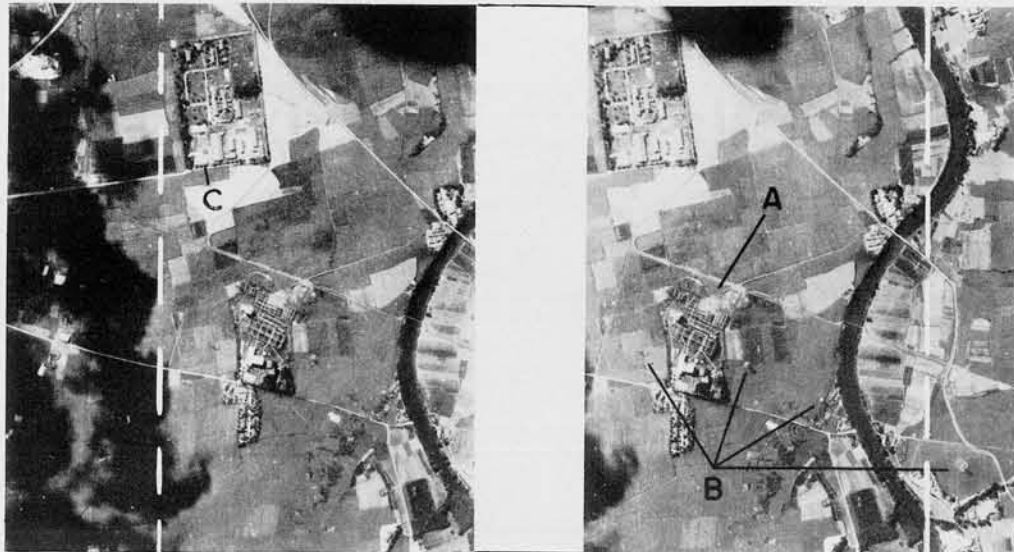
INAWASHIRO STATION NO.1



INAWASHIRO STATION NO.2

RELATED INSTALLATIONS

TRANSFORMERS



(R. F. - 1/16400)

LARGE TRANSFORMER STATION

Transformer station at Takao, Formosa.

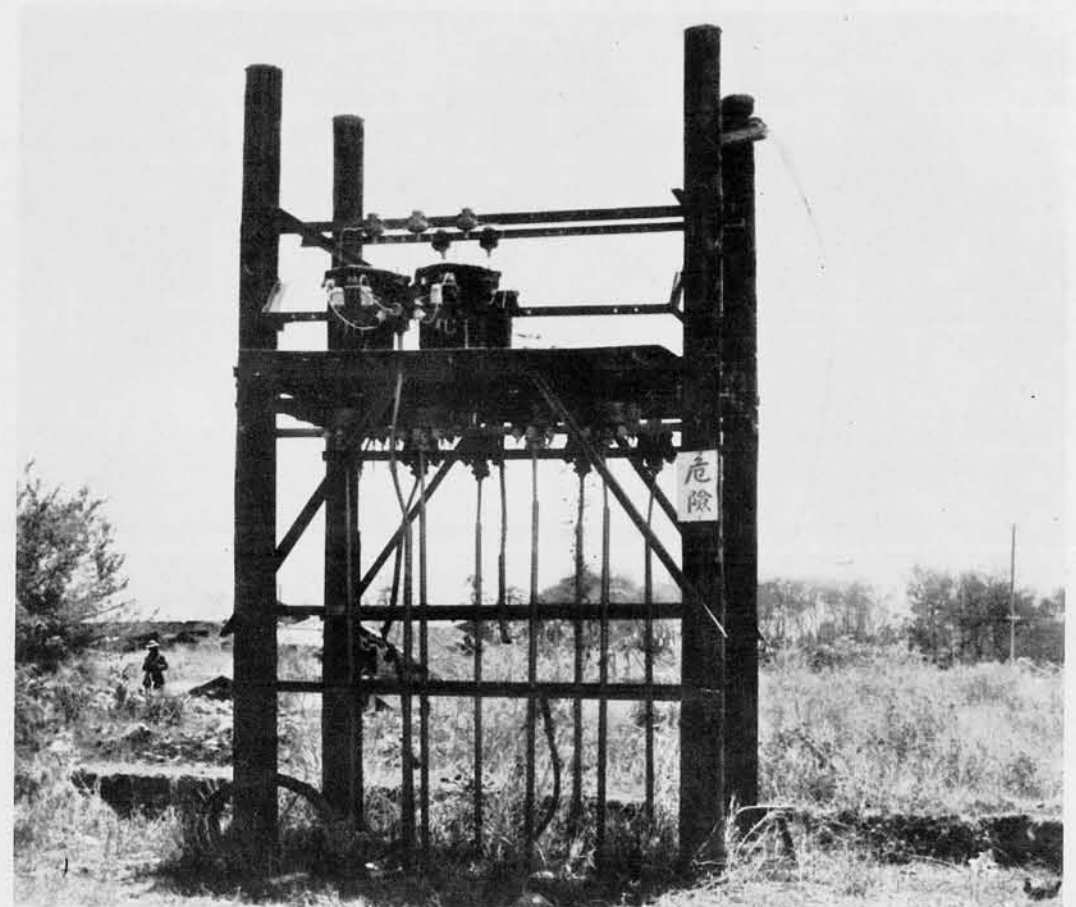
"A" - TRANSFORMERS

"B" - STEEL TOWERS SUPPORTING POWER LINES

Note Radio Station at "C".



MILITARY TRANSFORMER STATION



MILITARY TRANSFORMER STATION

Transformer platform is usually from 12 to 15 feet above ground and is about 8 feet square in vertical view.



MILITARY TRANSFORMER STATION

CONFIDENTIAL

RELATED INSTALLATIONS

TRANSFORMERS (CONT.)



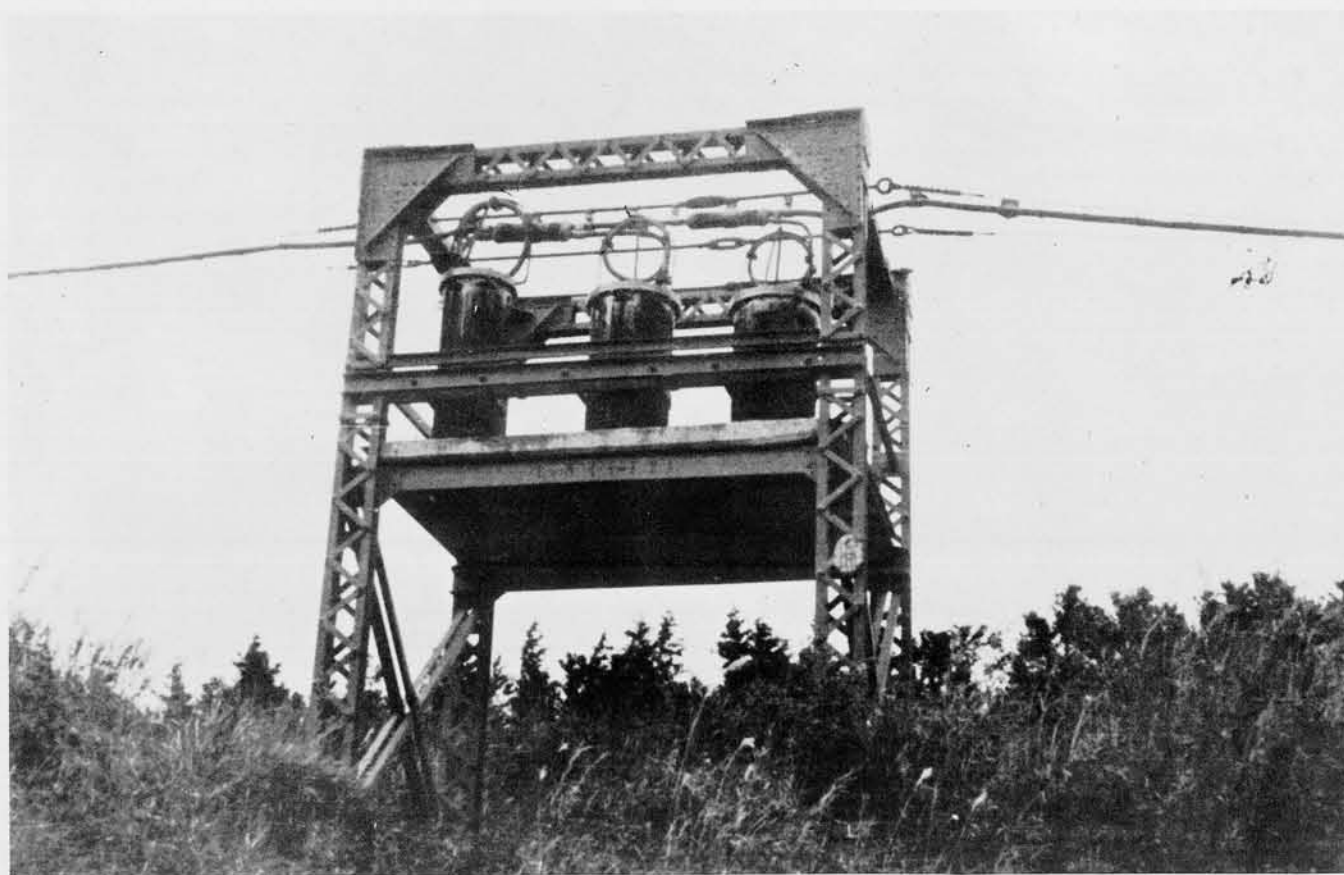
TELEPHONE CABLE, JAPAN

The above two pictures illustrate the method used for supporting central telephone cables in Japan. The loading coils are on heavy steel structures spaced up to 6000 feet apart.



TRANSFORMER

Well-concealed small military transformers at Guam. This sort of practice, not uncommon with Japanese installations, offers a real challenge to the interpreter.



TELEPHONE CABLE, JAPAN

The size and shape of these structures resemble the military transformer stations shown on the previous page. Although such installations may not be vital targets in themselves, they furnish valuable interpretation clues.



TRANSFORMER

Same military transformer on Guam uncovered. Entire installation is about 5 feet square.

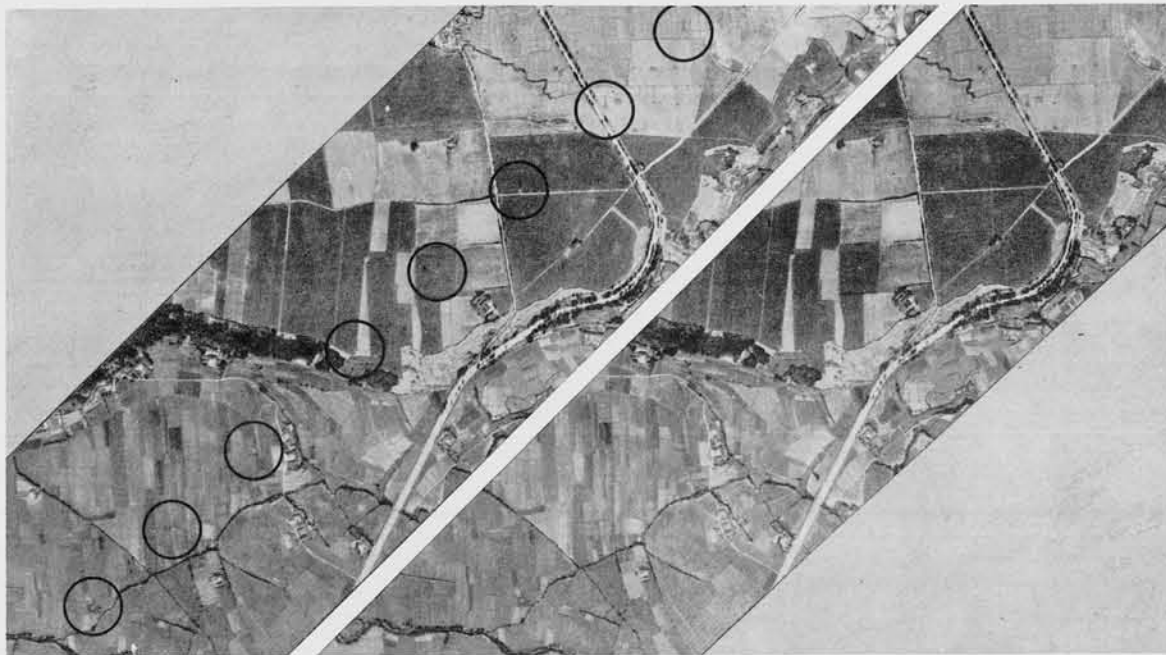


SMALL TRANSFORMER

Transformers for underground power plant - made by a United States company several years ago.

RELATED INSTALLATIONS

TRANSMISSION LINES



POWER · FORMOSA

High tension lines can be traced across the countryside in this example at Formosa.



POWER AND TELEPHONE POLES · SAIPAN



POWER SAIPAN



POWER SAIPAN

The above two views of transtormer station and power line on Saipan offer a good opportunity for reference.

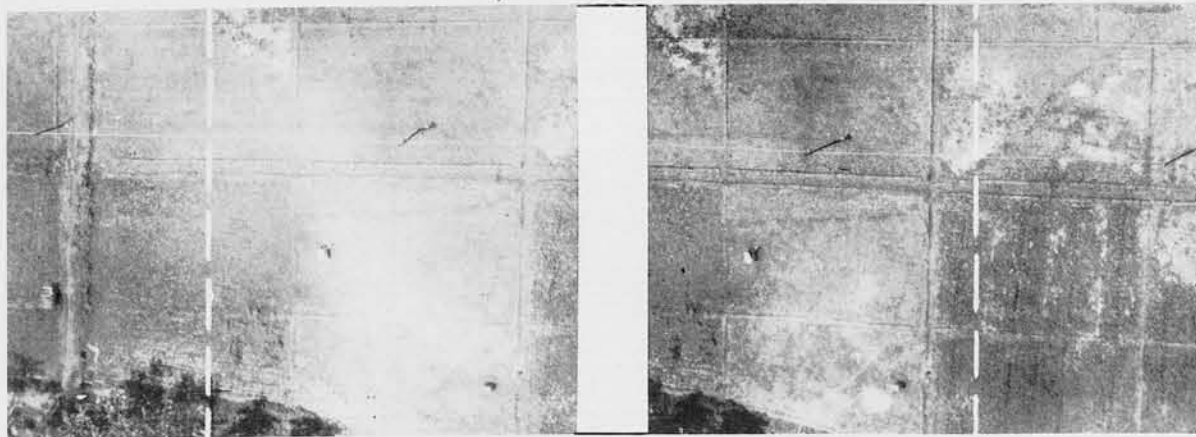
"A" - TRANSFORMER STATION

"B" - POWER LINE POLES

CONFIDENTIAL

RELATED INSTALLATIONS

TRANSMISSION LINES (CONT.)



TELEPHONE CABLE, GUAM



POWER LINE - JAVA



POWER OR PIPE LINE SLASH - PALAU

Examples are shown on this page of transmission and telephone lines. Steel towers, of the type shown on Java, may sometimes be mistaken for electronics devices such as radio or radar when examined singly, or in a picture of limited coverage.



POWER POLES - MANCHURIA



TELEPHONE POLES - SAIPAN

SUPPLEMENTARY MATERIAL

SECRET

SECTION-7

7.01 - 7.99

COMPARATIVE STUDIES

~~CONFIDENTIAL~~

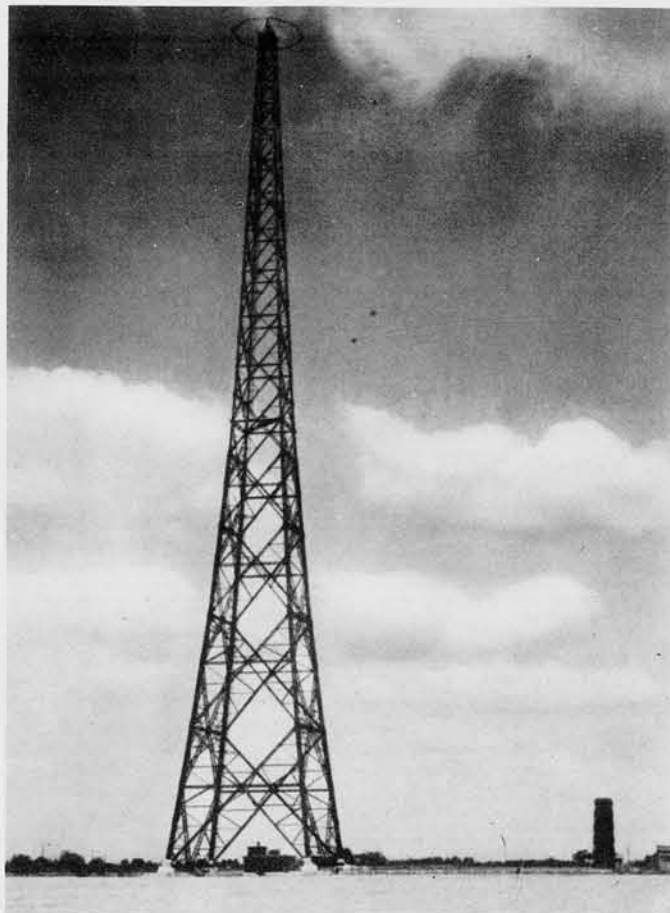
COMPARATIVE STUDIES

RADIO MASTS

This section, "Comparative Studies", was prepared as a general treatment of the interpretation of Electronics installations from aerial photographs.

Here are included a few pages illustrating comparisons and contrasts between electronics installations and certain similar appearing non-electronics forms as they show up in aerial photographs.

The first three pages are devoted to studies of radio masts of both Oriental and Occidental design.



GERMAN

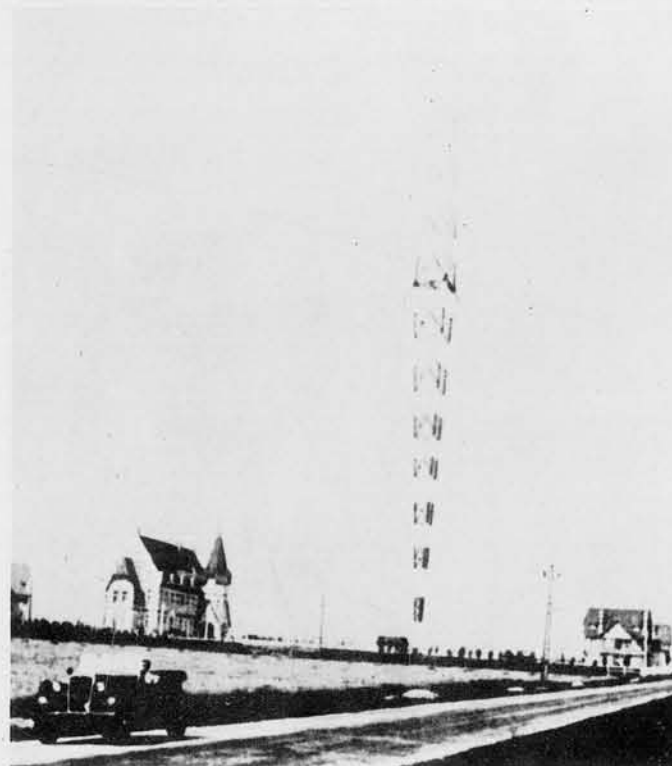
This lattice mast is of German design and is apparently a top loading radiating mast resting on insulators. The steel framework of the tower and the circular form at top transmits radio energy without need for other antennae.

CONFIDENTIAL



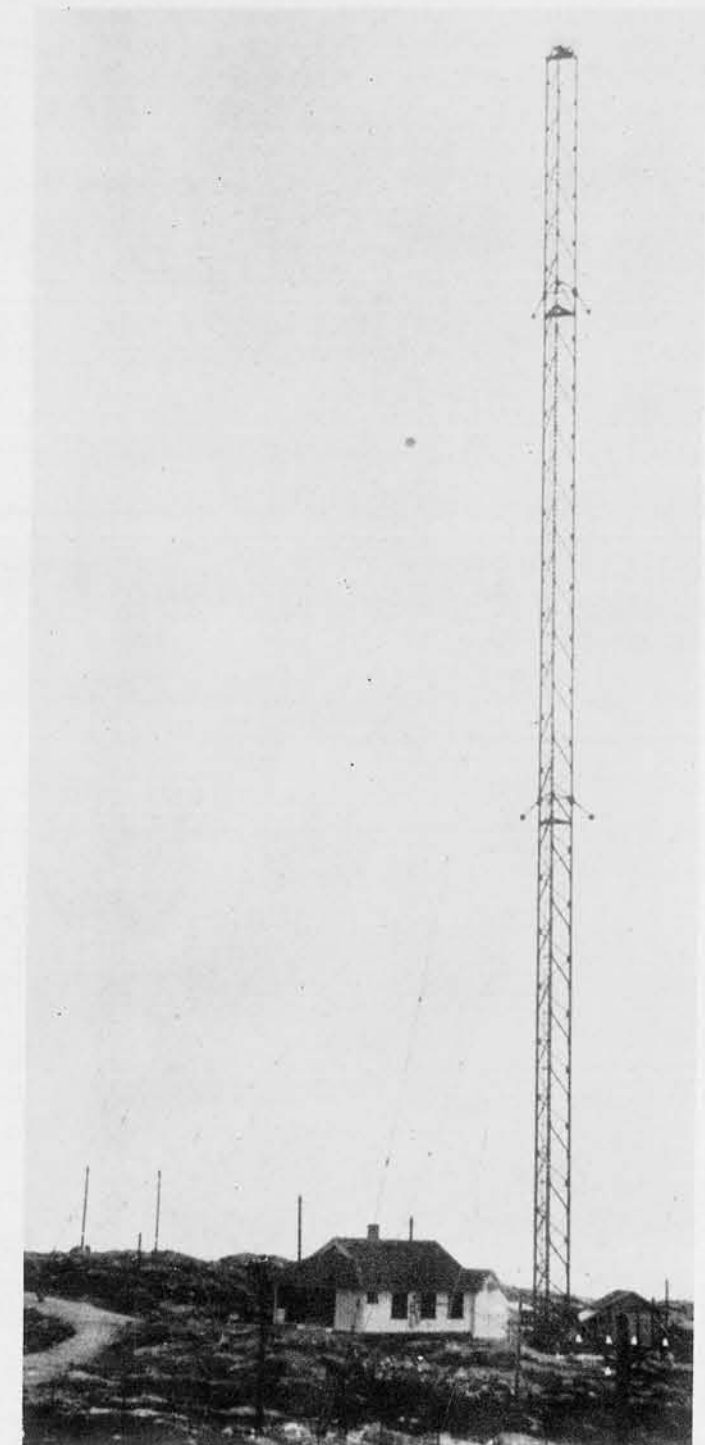
GERMAN

Two radiating masts of German design near Rapopo, New Britain. This was a prewar broadcast station. Note D.F. type towers nearby.



FRENCH

Mast of pre-war "Radio Normandie" broadcast station - Louvelat. Masts of this type, as well as others on this page, are seldom built by the military.

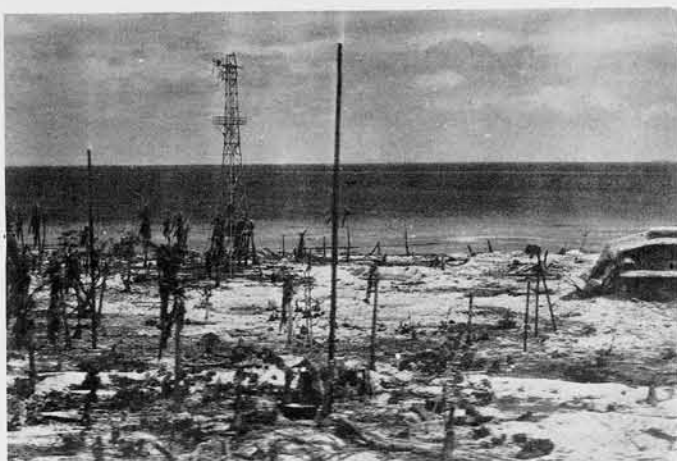


NORWEGIAN

Norwegian mast similar in design to those at Rapopo. This is a pre-war construction, also. All masts on this page are used with medium to low frequency communications.

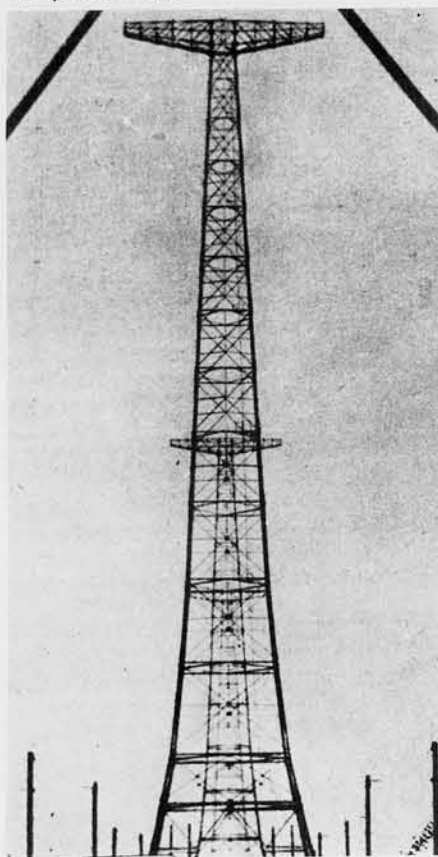
COMPARATIVE STUDIES

RADIO MASTS



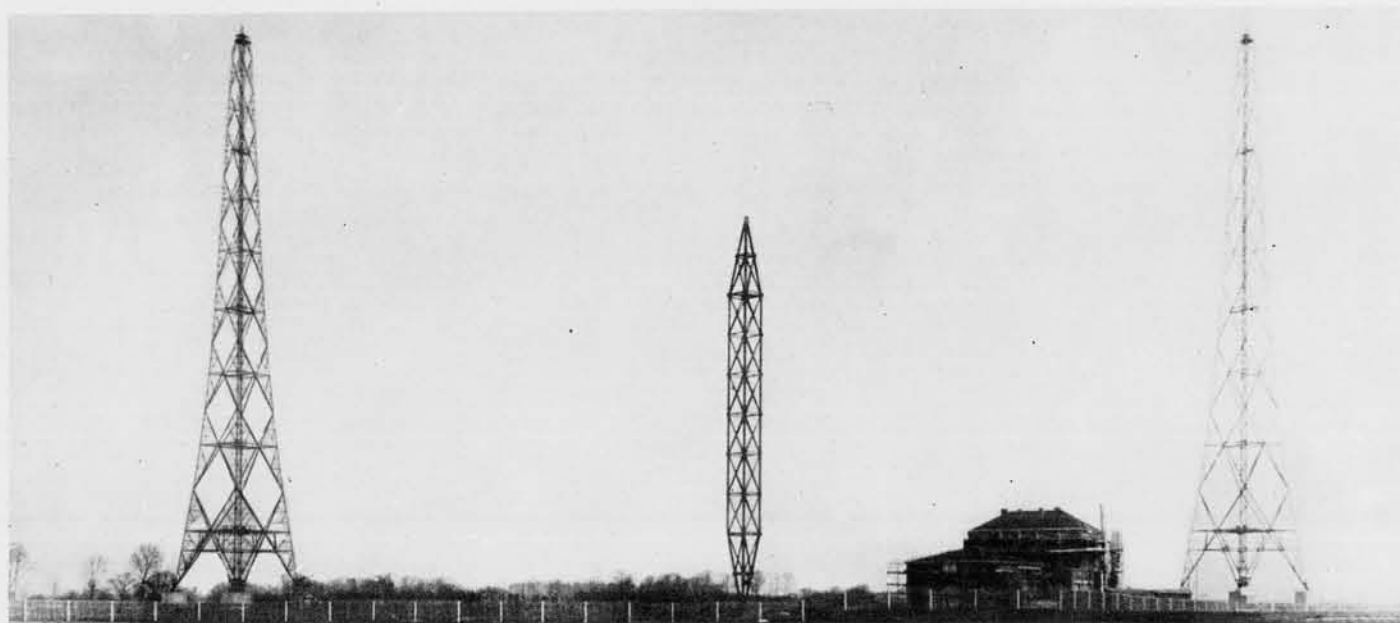
JAPANESE MILITARY STATION

When low wood stick masts are found in close proximity to steel lattice masts, the former probably carry antennae for transmission at higher frequencies.



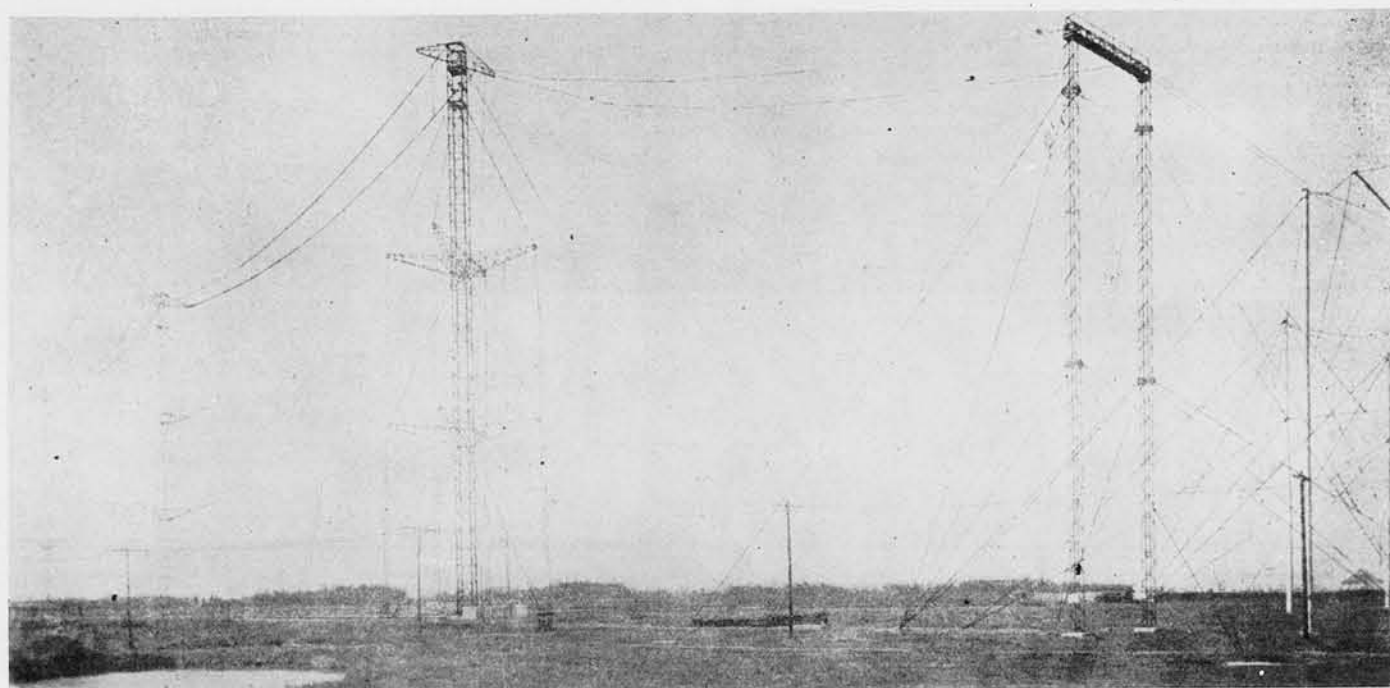
MANCHURIAN

Steel lattice masts of Japanese controlled low frequency station in Manchuria. This station was erected before the war.



GERMAN

Police radio station of pre-war design in Munich. These stations are probably of lower frequency than those commonly used by the German military in this war.

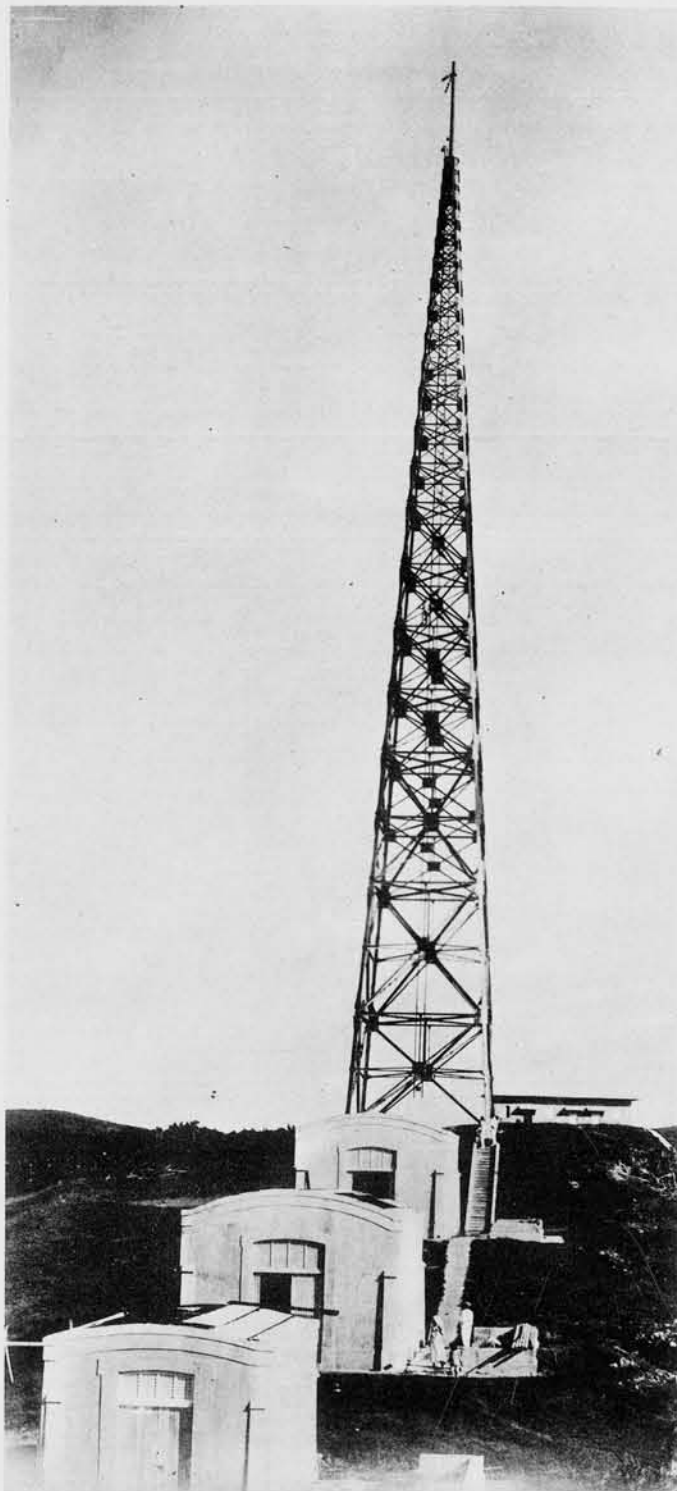


CHINESE

Complex array of antennae and masts used by the pre-war Chinese Government station at Shanghai, called the "Chenju" station. Masts similar to those at left (above) are sometimes used by the Germans for communications.

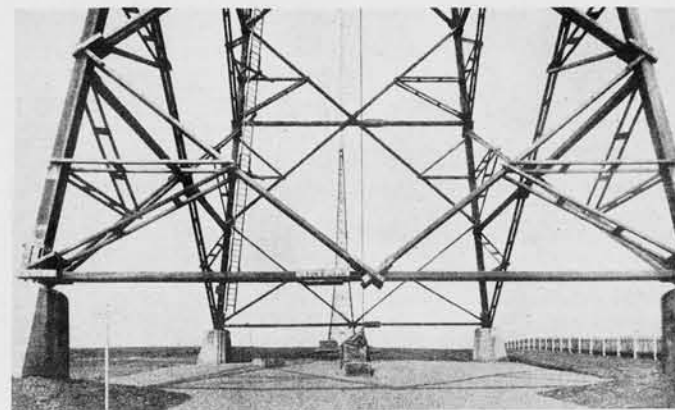
COMPARATIVE STUDIES

RADIO MASTS (CONT.)



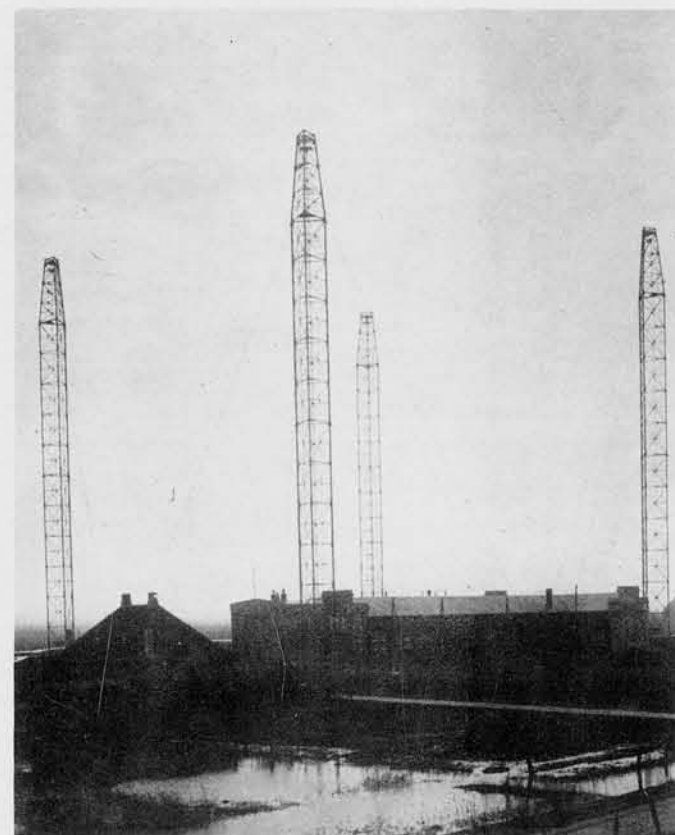
UNITED STATES

Old steel lattice mast at Santo Domingo de Basco. Picture was taken in 1928.



GERMAN

Broadcast station at Wurttemberg, built during 1920's. Bases of masts are made of wood.



GERMAN

Ship to shore station located in Germany. This station undoubtedly has long range and may have navigational aid capacities.



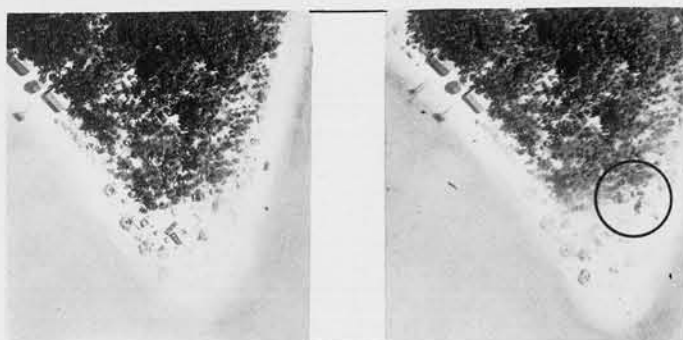
SWEDEN

Steel latticemasts of Stockholm Radio Station. Note radiating pattern of buried cable emanating from transmitter house. Patterns of this type indicate a ground mat or the presence of tuning houses.

CONFIDENTIAL

COMPARATIVE STUDIES

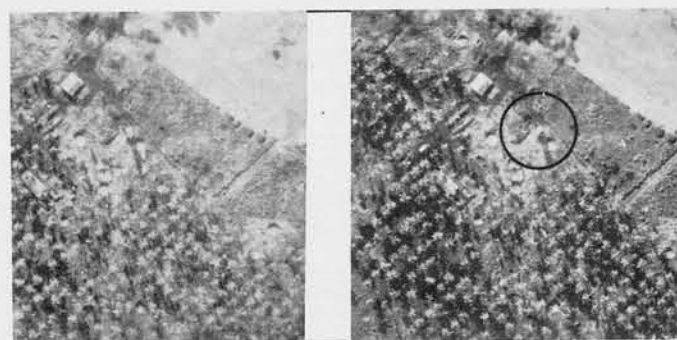
OBSERVATION TOWERS



TARAWA

(R.F. - 1/6700)

Wooden observation tower at Tarawa. Such towers are necessary on low coral islands for lookouts and for artillery observation.



TOBERA

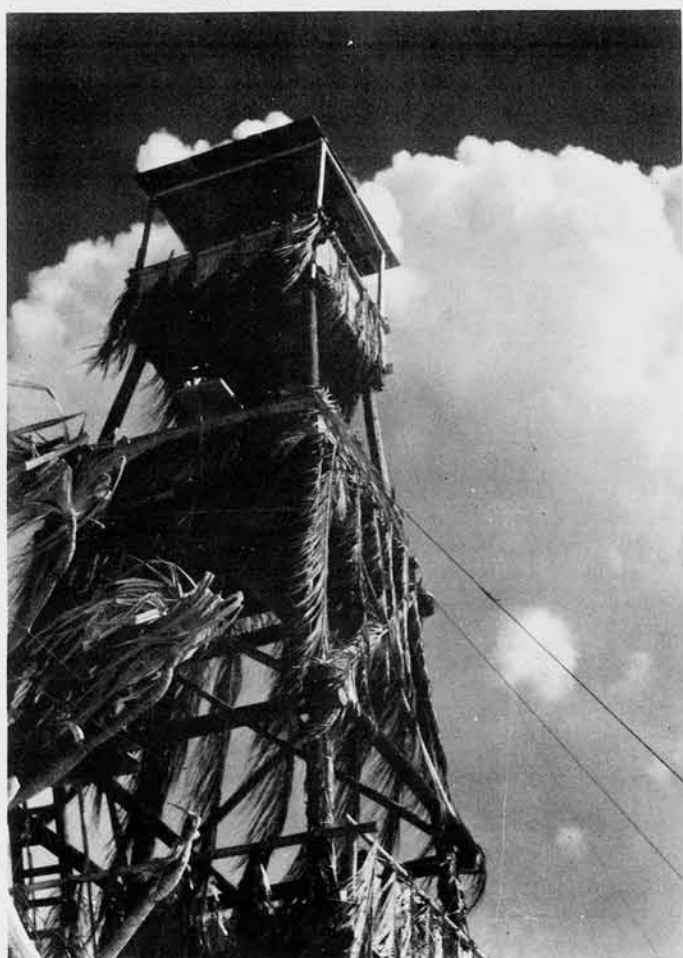
(R.F. - 1/5500)

Wooden observation towers are usually between 40 and 60 feet in height.



UTIRIK

Countless styles of design are found in Japanese observation towers, yet most reflect a nationalistic flavor in arrangement of architectural forms.



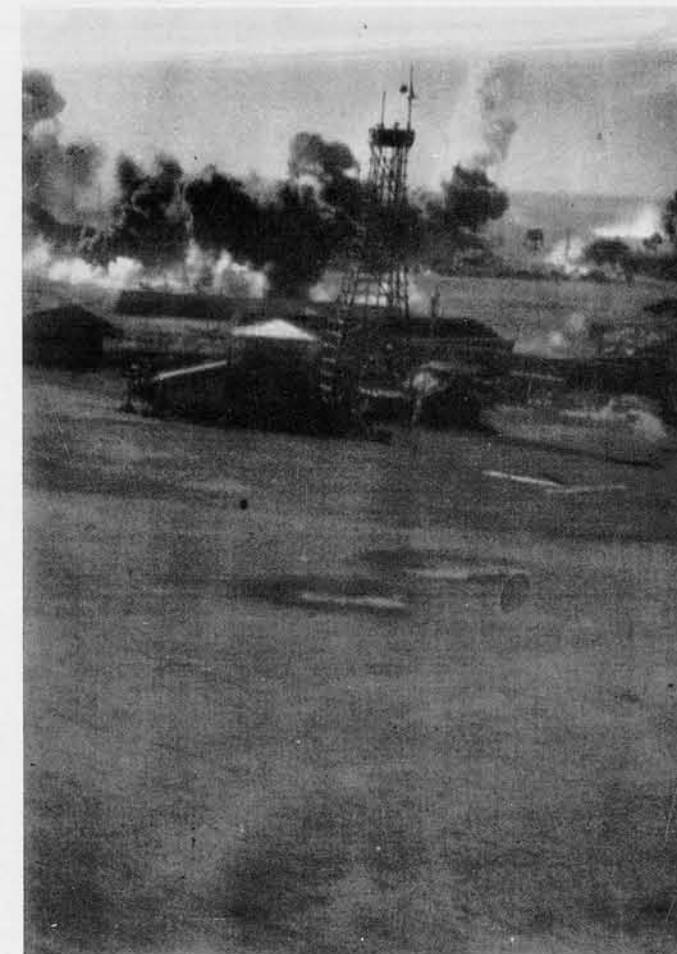
TARAWA

Same tower at Tarawa, which was used with coast defense guns. Note telephone wires and palm frond camouflage.



GUAM

Observation tower near Orote Airfield. Note palm frond camouflage and presence of communications lines. Sometimes observation towers near airfields are used as control towers. However, the platform is usually covered and will contain high frequency radio communication in such cases.

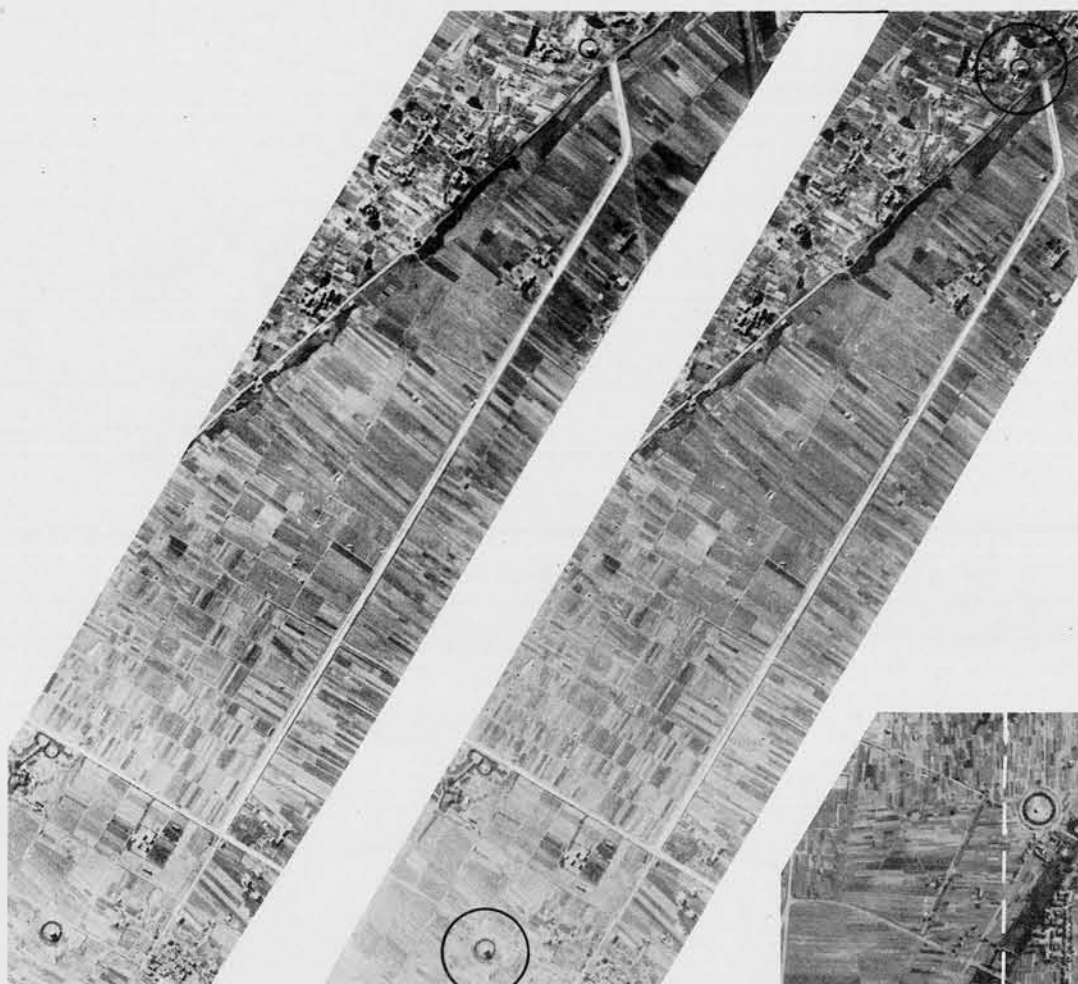


MALOELAP

The structural members of a wooden observation tower are likely to give a more horizontal effect than a steel lattice mast. Steel structural members are seldom bent in this manner.

COMPARATIVE STUDIES

DIRECTION FINDERS



HANKOW

(R.F. - 1/17000)



HANKOW

D.F. tower at end of runway surrounded by a square enclosure which is mindful of the German method. D.F. is nearly always present near airfields and each installation is reached by a road or path connection.



HANKOW

These fuel storage tanks at Hankow, China (shown in two stereograms on this page) resemble D.F. stations in small scale photography--especially when near an airfield, or connected by a strong pattern of roads.

Close examination reveals them to be floating top tanks, 35 feet in diameter, surrounded by moats.



YUNCHENG

This installation at Yuncheng is probably a high frequency D.F. tower surrounded by a circular levee for protection against flood. Note small auxiliary buildings within levee. Compare this with fuel tanks at Hankow.

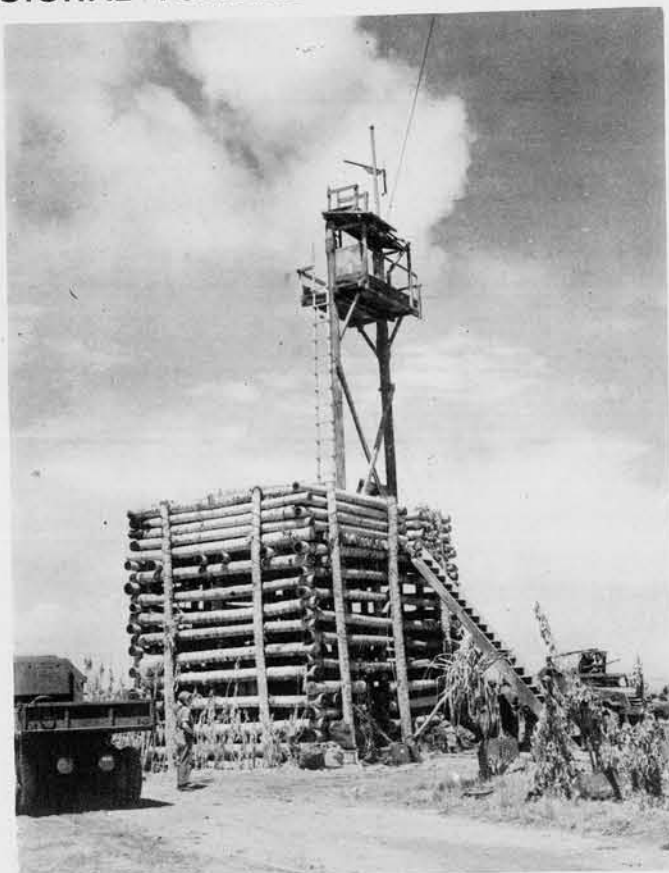
General: There are many comparatively innocent objects that may be confused with vital electronics installations as well as countless camouflage methods and even illusions created by chance.



CONFIDENTIAL

COMPARATIVE STUDIES

SIGNAL TOWERS



MAKIN

ABOVE:

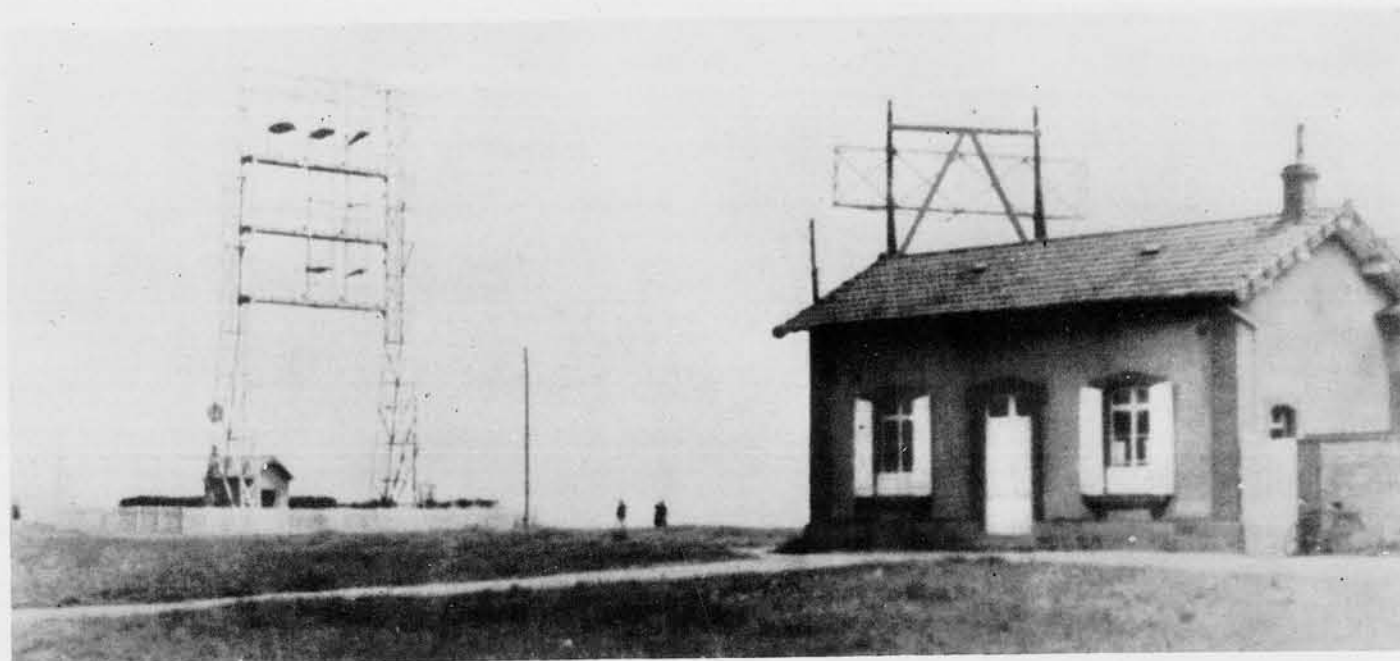
Japanese signal tower at Makin, Gilberts. This base is constructed of coconut logs, lashed together at the corners. Upper portion is braced with guy wires. Note communications line. Tower is approximately 50 feet above ground.

RIGHT:

Although not properly classified as a "Signal Tower", these are shown here for reference. It is thought that this type of tower is used in connection with port direction.

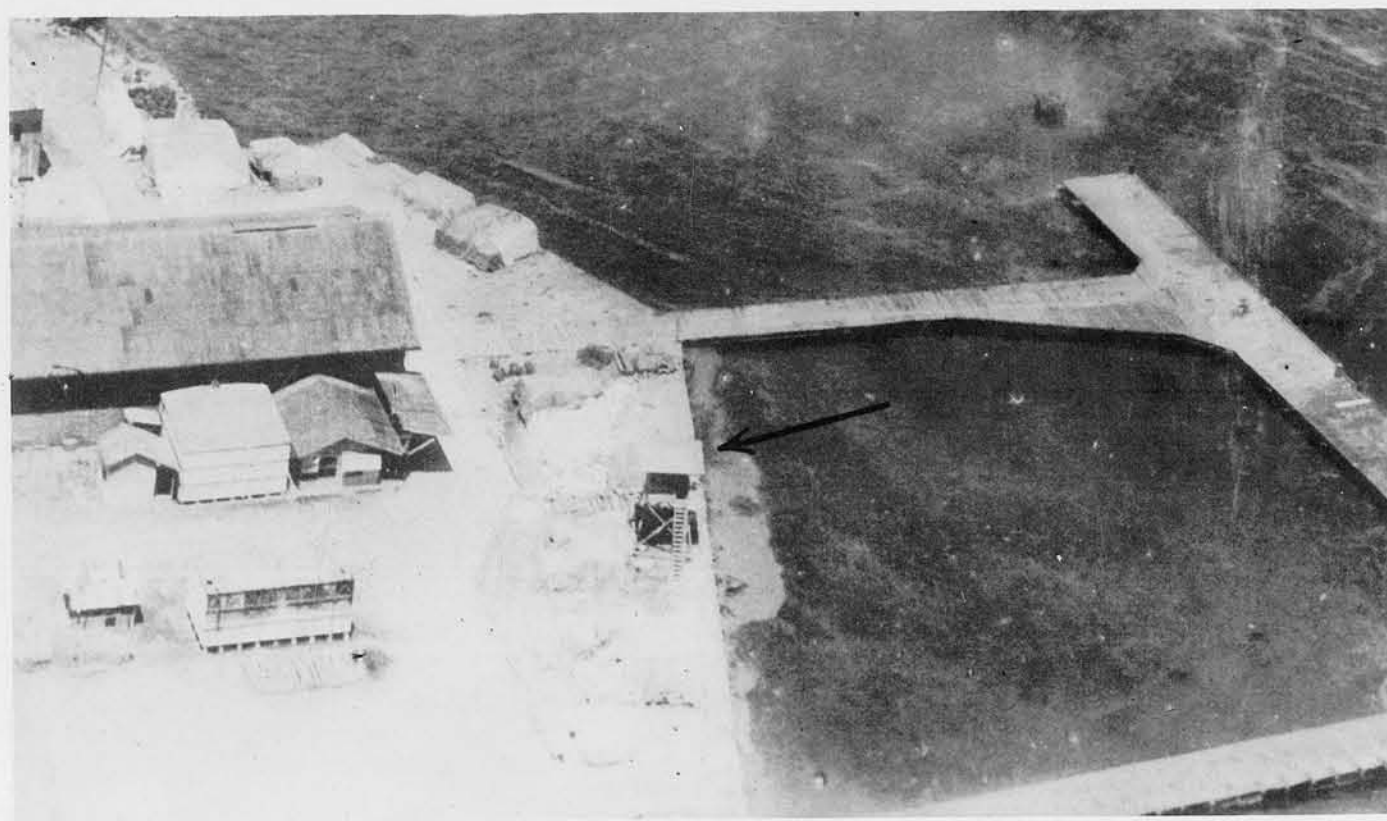
Signal towers, observation towers, as well as many electronics buildings often vary in design because of the whims of local commanders, local builders, and emergency needs - despite the fact that the Japanese military have standard designs for most structures. Even an improvised radar antenna has been found.

This is in contrast to the orderly Germans, whose installations vary from a few standard types but little, and then usually only in dimension.



FRANCE

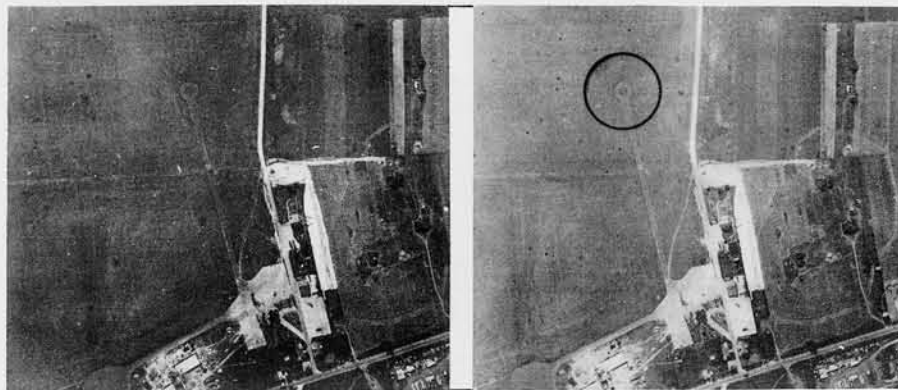
Signal station and semaphore situated near the ocean.



RABAU, NEW BRITAIN

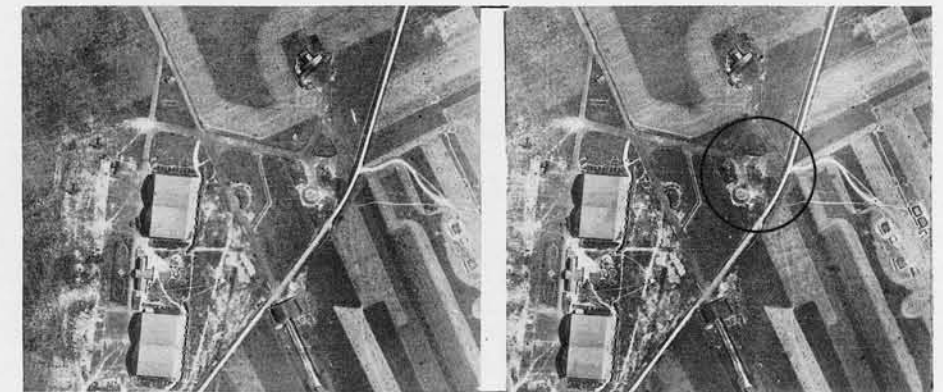
COMPARATIVE STUDIES

MISCELLANEOUS



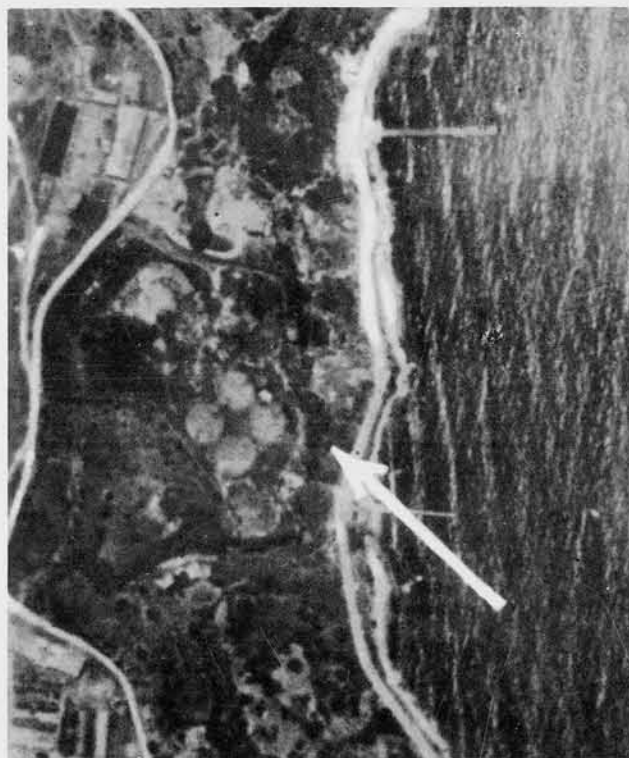
GERMAN COMPASS SWINGING BASE (R.F. - 1/8300)

Most German airfields contain circular patterns connected to a runway spur, which are "compass swinging bases." These are used for checking and setting the plane's compass before taking off on a mission.



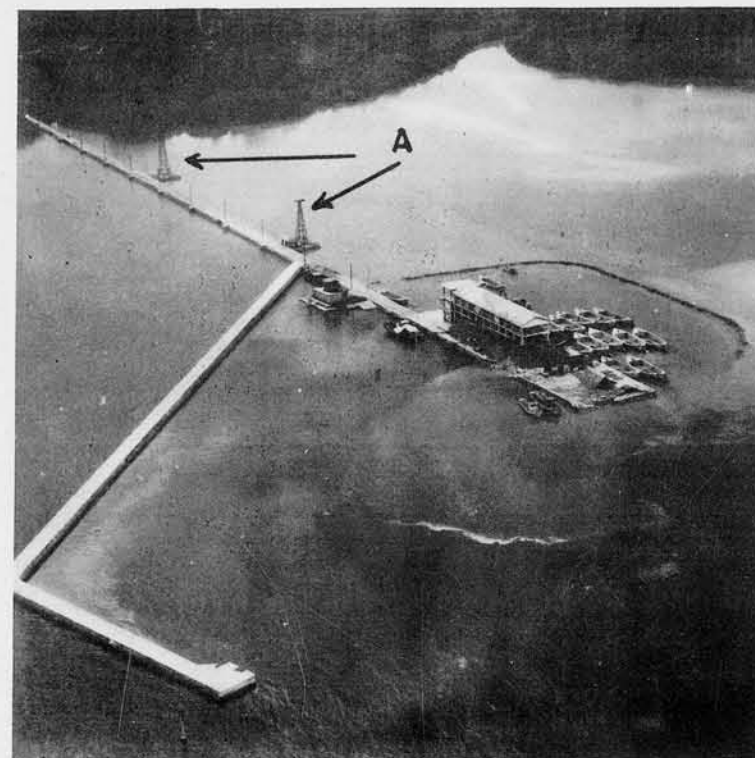
GERMAN COMPASS SWINGING BASE (R.F. - 1/8000)

Another German "compass swinging base" (possibly two). Such installations have not been observed on Japanese airfields to date, as far as is known.



BURIED FUEL TANKS

Buried fuel tanks may look like German type medium frequency Adcock D.F., as can be seen from above photograph.



CABLE CAR TOWERS

Occasionally, steel towers may be mistaken for radio masts. In this view are two towers which support a cable car used in connection with certain types of industry. This tower design, however, is slightly different from Japanese standard types of radio masts.



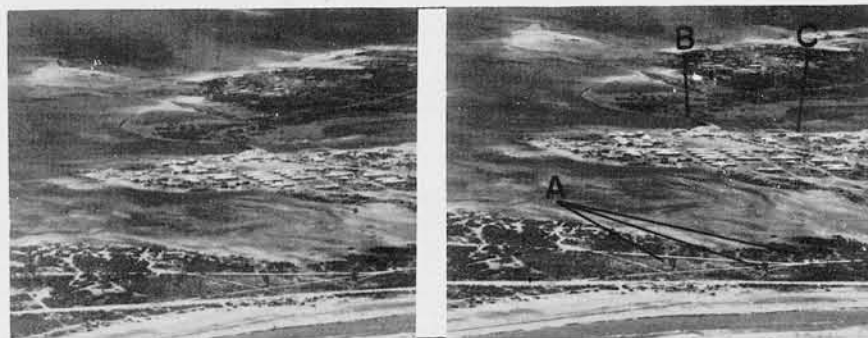
DECOY D.F.

What appears to be an Adcock D.F. is actually light-toned ridgelines on the roof of a building in German-held territory.

CONFIDENTIAL

COMPARATIVE STUDIES

MISCELLANEOUS



WAKE

In this stereo-oblique are three types of towers used for entirely different purposes.

"A" - HIGH FREQUENCY D. F.

"B" - PROBABLE OBSERVATION TOWER

"C" - WATER TOWER

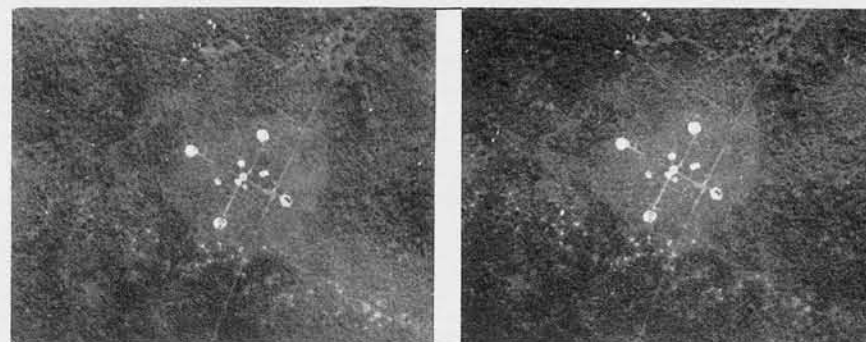


WAKE

Vertical stereogram of a portion of the same area as stereo-oblique shown above.

"A" - TELEPHONE LINE

"B" - PROBABLE OBSERVATION TOWER



AA BATTERY

(R.F. - 1/6000)

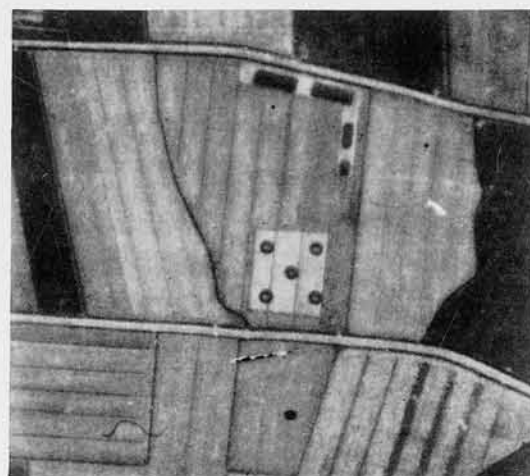
The above pattern, first suggestive of a medium frequency Adcock D. F., is either a new medium AA battery or a decoy. Photograph was taken over Japanese-held territory.



WATER PURIFICATION

(R.F. - 1/16400)

This arrangement of forms in Takao, Formosa, indicates a water purification process. The circular form contains the type of geometry often found in electronics installations.



DECOY AA



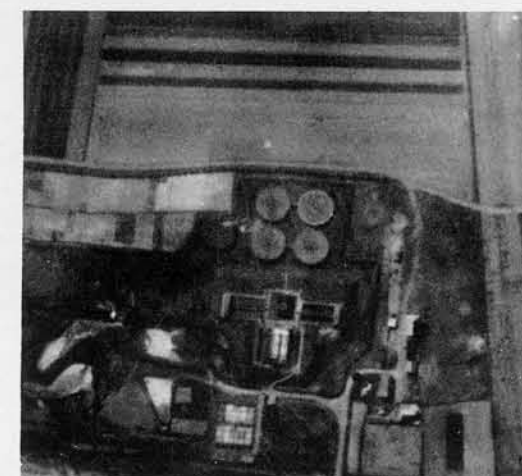
DOMESTIC PATTERN (R.F. - 1/3500)

The circular forms (above) are probably the result of using primitive sugar cane processing apparatus. LEFT: Compare this decoy AA position (German battery) with Japanese AA position on this page. Both may be confused with electronics.



PROBABLE DUMMY RADAR

RIGHT: Sewage plants, at small scale may often appear to be electronics installations. Surrounding buildings and activities usually prevent such an error in identification, however.



SEWAGE PLANT

SUPPLEMENTARY MATERIAL

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